Encyclopaedia Britannica:

OR, A

DICTIONARY

OF

ARTS, SCIENCES, AND MISCELLANEOUS LITERATURE;

ENLARGED AND IMPROVED.

THE SIXTH EDITION.

Illustrated with nearly six hundred Engravings.

VOL. XX.

INDOCTI DISCANT; AMENT MEMINISSE PERITI.

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Suicide.

SUICIDE, the crime of self-murder, or the person who commits it.

We have often wished to see a history of crimes drawn up by a man of ability and research. In this history we would propose that the author should describe the crimes peculiar to different nations in the different stages of society, and the changes which they undergo in the progress of civilization. After having arranged the historical facts, he might, by comparing them with the religion and the knowledge of the people, deduce some important general conclusions, which would lead to a discovery of the cause of crimes, and of the remedy most proper to be applied. Some crimes are peculiar to certain stages of society, some to certain nations, &c.

1 Suicide among the Jews.

Suicide is one of those crimes which we are led to believe not common among savage nations. The first instances recorded of it in the Jewish history are those of Saul and Ahitophel; for we do not think the death of Samson a pro, 'r example. We have not reason to suppose that it became common among the Jews till their wars with the Romans, when multitudes slaughtered themselves that they might not fail alive into the hands of their enemies. But at this period the Jews were a most desperate and abandoned race of men, had corrupted the religion of their fathers, and rejected that pure system which their promised Messiah came to Jerusalem to announce.

2 Among the Greeks.

When it became remarkable among the Greeks, we have not been able to discover; but it was forbidden by Pythagoras, as we learn from Athenæus, by Socrates and Aristotle, and by the Theban and Athenian laws. In the earliest ages of the Roman republic it was seldom committed; but when luxury and the Epicurean and Stoical philosophy had corrupted the simplicity and virtue of the Roman character; then they began to seek shelter in suicide from their misfortunes or the effects of their own vices.

3 The Bramins and Gentoos.

The religious principles of the bramins of India led them to admire suicide on particular occasions as honourable. Accustomed to abstinence, mortification, and the contempt of death, they considered it as a mark of weakness of mind to submit to the infirmities of old age. We are informed that the modern Gentoos, who still in most things conform to the customs of their ancestors, when old and infirm, are frequently brought to the banks of rivers, particularly to those of the Ganges, that they may die in its sacred streams, which they believe can wash away the guilt of their sins. But the maxims of the bramins, which have encouraged this practice, we are assured by Mr Holwell, are a corruption of the doctrines of the Shastah, which positively forbid suicide under the severest punishment. The practice which religion or affection has established among the Gentoos, for women at the death of their husbands to burn themselves alive on the funeral pile, we do not think ought to be considered as suicide, as we are not anxious to extend the meaning of the word; for were we to extend it thus far, it would be as proper to apply it to those who choose rather to die in battle than make their escape at the expence of their honour. Thus we should condemn as suicides the brave Spartans who died at Thermopylæ in defence of their country; we should also be obliged to apply the same disgraceful epithet to all those well-meaning but weak-minded Christians in this island, who in the last century chose rather to die as martyrs than comply with commands which were not morally wrong. According to the Gentoo laws, "it is proper for a woman after her husband's death to burn herself in the fire with his corpse. Every woman who thus burns shall remain in paradise with her husband three crore and fifty lacks of years. If she cannot, she must in that case preserve an inviolable chastity. If she remain chaste, she goes to paradise; and if she do not preserve her chastity, she goes to hell."

Sullivan's Phil. Rhap. vol. ii. Holwell's Interesting Events, &c. vol. i.

4 Among the Americans.

A custom similar to this prevailed among many nations on the continent of America. When a chief died, a certain number of his wives, of his favourites, and of his slaves, were put to death, and interred together with him, that he might appear with the same dignity in his future station, and be waited upon by the same attendants. This persuasion is so deeply rooted, that many of their retainers offer themselves as victims; and the same custom prevails in many of the negro nations in Africa.

Robertson's America.

5 The Japanese, and

If we can belive the historians of Japan, voluntary death is common in that empire. The devotees of the idol Amida drown themselves in his presence, attended by their relations and friends, and several of the priests, who all consider the devoted person as a saint who is gone to everlasting happiness. Such being the supposed honours appropriated to a voluntary death, it is not surprising that the Japanese anxiously cherish a contempt of life. Accordingly it is a part of the education of their children "to repeat poems in which the virtues of their

Raynal's Hist. of the East and West Indies, vol. i.

ancestors are celebrated, an utter contempt of life is inculcated, and suicide is set up as the most heroic of actions."

6
Scythians,

A notion seems also to have prevailed among the ancient Scythian tribes, that it was pusillanimous and ignoble for a man whose strength was wasted with disease or infirmity, so as to be useless to the community, to continue to live. It was reckoned an heroic action voluntarily to seek that death which he had not the good fortune to meet in the field of battle. Perversion of moral feeling does not spring up, we hope, spontaneously in any nation, but is produced by some peculiarities of situation. A wandering people like the Scythians, who roamed about from place to place, might often find it impossible to attend the sick, or to supply from their precarious store the wants of the aged and infirm. The aged and infirm themselves, no longer able to support the character of warriors, would find themselves unhappy. In this way the practice of putting to death such persons as were useless to the community might originate, and afterwards be inculcated as honourable; but he who put an end to his infirmities by his own hand, obtained a character still more illustrious.

7
and Scandinavians.

The tribes of Scandinavia, which worshipped Odin the "father of slaughter," were taught, that dying in the field of battle was the most glorious event that could befal them. This was a maxim suited to a warlike nation. In order to establish it more firmly in the mind, all were excluded from Odin's feast of heroes who died a natural death. In Asgardia stood the hall of Odin; where, seated on a throne, he received the souls of his departed heroes. This place was called *Valhalla*, signifying "the hall of those who died by violence." Natural death being thus deemed inglorious, and punished with exclusion from Valhalla the paradise of Odin, he who could not enjoy death in the field of battle was led to seek it by his own hands when sickness or old age began to assail him. In such a nation suicide must have been very common.

8
It prevailed much in the decline of the Roman empire.

As suicide prevailed much in the decline of the Roman empire, when luxury, licentiousness, profligacy, and false philosophy, pervaded the world, so it continued to prevail even after Christianity was established. The Romans, when they became converts to Christianity, did not renounce their ancient prejudices and false opinions, but blended them with the new religion which they embraced. The Gothic nations also, who subverted the Roman empire, while they received the Christian religion, adhered to many of their former opinions and manners. Among other criminal practices which were retained by the Romans and their conquerors, that of suicide was one; but the principles from which it proceeded were explained, so as to appear more agreeable to the new system which they had espoused. It was committed, either to secure from the danger of apostasy, to procure the honour of martyrdom, or to preserve the crown of virginity.

9
Too common in modern times, but not more so in England than in other countries.

When we descend to modern times, we lament to find so many instances of suicide among the most polished nations, who have the best opportunities of knowing the atrocity of that unnatural crime. The English have long been reproached by foreigners for the frequent commission of it; and the "gloomy month of November" has been stigmatized as the season when it is most common. But this disgraceful imputation, we think, may be justly attributed, not to the greater frequency of the crime in England than in other places, but to the custom of publishing in the newspapers every instance of suicide which is known. Mr Moore, who lately published a full inquiry into this subject, was at great pains to obtain accurate information concerning the perpetration of this crime in different countries. Mercier, who wrote in 1782, says, that the annual number of suicides in Paris was then about 150. He does not tell us how he came by the information; but we have the authority of the Abbe Fontana for asserting, that more persons put an end to their lives in Paris than in London. The Abbe had this information from the lieutenant of the police. Mr Moore was informed by one of the principal magistrates of Geneva, that in that city, which contains about 25,000 inhabitants, the average number of suicides is about *eight*. The average number of suicides, from what cause soever, for the last 28 years, has been 32 each year for London, Southwark, and Westminster. In Edinburgh, which contains 80,000 inhabitants, we are convinced the average number of suicides does not exceed *four*. Mr Moore found, from the accounts with which he was favoured by the several coroners of the county of Kent, that for the last 18 years the number has been upwards of 32 each year. Kent is supposed to contain 200,000 inhabitants, and London 800,000. It is easy therefore to see, that in the metropolis many instances of suicide must occur which are never the subject of legal inquiry, and consequently never made known to the world. Whereas in the country towns and villages of Kent it is scarcely possible to conceal such an action as self-murder from the knowledge of the whole neighbourhood. The calculation therefore respecting Kent we may receive as true, while we must increase the average number in London very considerably. Mr Moore computes the average number of suicides in England every year at a thousand; but the principles on which he founds this opinion are so imperfect and vague, that we do not think it can be depended on as coming near the truth.

Mercier's Tableau de Paris.

10
The number of suicides in Paris, London, Geneva, &c. according to the best accounts.

11
In what rank and situation suicide is most common.

It might lead to some interesting conclusions to compare together, not only the number of suicides in different countries, but also the rank and principles, the sex and age, of those unhappy persons by whom it has been committed. Mercier says, that at Paris it was the lower ranks who were most commonly guilty of it; that it was mostly committed in garrets or hired lodgings; and that it proceeded from poverty and oppression. A great many, he says, wrote letters to the magistrates before their death. Mr Moore's correspondent from Geneva informed him, that from the year 1777 to 1787 more than 100 suicides were committed in Geneva; that two-thirds of these unfortunate persons were men; that few of the clerical order have been known to commit it; and that it is not so much the end of an immoral, irreligious, dissipated life, as the effect of melancholy and poverty. By the information obtained from the coroners of Kent, it appears, that of the 32, three-fourths have destroyed themselves by hanging; that the proportion of males to females has been about two-thirds of the former; that no one season of the year is more distinguished for this crime than another; and that suicide is upon the increase. Our accounts respecting the city of London are very imperfect; but we think ourselves intitled to conclude, that suicide is more common among the great and wealthy

Moore's Full Inquiry into the Causes of Suicide.

Suicide.

wealthy than among the lower ranks, and that it is usually the effect of gaming and dissipation.

12 Physical causes to which it has been ascribed in Britain.

Those who have inquired into the causes of suicide in Britain have enumerated many physical as well as moral causes. They have ascribed it to the variableness of our climate, to the great use of animal food, to strong spirituous liquors, to tea, and to the sulphureous exhalations of the pit coal used as fuel, which are said to produce a depression of spirits and nervous affections. Of our climate, we have no cause to complain, nor have we any reason to impute any of our vices to its influence. There are many climates much more unfavourable where suicide is scarcely known. That an excessive quantity of gross animal food, or of strong liquors, or of tea, will powerfully affect the human constitution, we will not deny: but before we consider these as causes, it must first be determined, whether those who are guilty of self-murder be much addicted to them; and if they are, whether there be not other causes much more violent in their nature which have operated on their minds; for we ought not rashly to attribute vicious effects to any of those things which seem to have been created on purpose for the comfort or convenience of man. We are rather surprised to find that coal is mentioned even as a distant cause of suicide; for it is one of the blessings of our island; and a good coal fire we have always found rather conducive to good spirits than injurious to them.

13 And moral causes.

Among the moral causes which are supposed to cooperate in producing suicide in Britain, the freedom of our constitution and laws is reckoned one. That rational liberty should have any tendency to encourage crimes of any kind, a Christian philosopher can never allow; for such an opinion is totally discountenanced by enlightened views of nature. Mercier has ascribed the frequency of suicide in Paris to the oppression of the late government. Now it appears somewhat extraordinary, that suicide in one country should be occasioned by liberty, and in another by the want of it. One of these opinions must be false, and it is surely not difficult to distinguish which.

14 Not owing always to insanity.

Humanity would in most cases dispose us to conclude, that suicide is the effect of insanity, were there not so many instances of cool deliberate self-murder. That suicide is an unnatural crime, which none but a madman would commit, compassion indeed may suppose; but the murder of a wife, a father, or a child, are also unnatural; yet compassion does not teach us in all cases to ascribe such a crime to madness. Passion may often arise to such a height of outrage as to be scarcely distinguishable from madness in its symptoms and its effects; yet we always make a distinction between that madness which arises from disease and that which is owing to a violent perturbation of mind. If a person be capable of managing his wordly affairs, of making a will, and of disposing of his property, immediately before his death, or after he formed the resolution of dying by his own hands, such a man is not to be considered as insane.

15 but often also to vicious passion.

But though a regard for truth prevents us from ascribing suicide in all cases to insanity, we must ascribe it either to insanity or to vicious passion. These two divisions, we imagine, will comprehend every species of it, whether arising from melancholy, *tædium vitæ* or *ennui*, disappointment in schemes of ambition or love, pride, gaming, or a desire to avoid the shame of a public execution; passions which are often increased by false views of God, of man, and of a future state, arising from deism and infidelity. If these be the causes of suicide in modern time, what a disgraceful contrast do they form to those principles which actuated many of the ancient philosophers, the Gentoos, the Japanese, and the worshippers of Odin? When they committed suicide, they committed it from principle, from a belief of its lawfulness, and the hope of being rewarded for what they judged an honourable sacrifice. But in modern times, we are sorry to say, when it is not the effect of madness, it is the effect of vice: and when it is the effect of vice, it proves that the vicious passions are then indulged to the highest degree; for there is no crime which a man can commit that is so strong a symptom of the violence of particular passions. It is from not attending to this circumstance, that it has been found so difficult to refute the arguments in favour of suicide. If the criminality of suicide be confined merely to the violent action, many apologies may be made for it; but if it be considered solely as the effect of vice, as the strongest symtom of ungoverned passion, he who undertakes its defence must undertake the defence of what all men will loudly condemn (A).

It

(A) Several of the heathens entertained a very just sense of the atrocity of suicide. Quintus Curtius introduces Darius with the following speech, when he had lost his empire: "I wait (says the unfortunate monarch) the issue of my fate: you wonder, perhaps, that I do not terminate my own life; but I choose rather to die by the crime of another than by my own.

We cannot refuse ourselves the pleasure of presenting to our readers the following beautiful passage upon this subject from Fitzosborne's letters*: "I am persuaded (says this elegant writer) this disgust of life is frequently indulged out of a principle of mere vanity. It is esteemed as a mark of uncommon refinement, and as placing a man above the ordinary level of his species, to seem superior to the vulgar feelings of happiness. True good sense, however, most certainly consists not in despising, but in managing our stock of life to the best advantage, as a cheerful acquiescence in the measures of Providence is one of the strongest symptoms of a well-constituted mind. Self-weariness is a circumstance that ever attends folly; and to condemn our being is the greatest, and indeed the peculiar infirmity of human nature. It is a noble sentiment which Tully puts into the mouth of Cato, in his Treatise upon old Age; *Non lubet mihi* (says that venerable Roman) *deplorare vitam, quod multi, et ii docti, sæpe fecerunt; neque me vixisse poenitet: quoniam ita vixi, ut non frustra me natum existimem.*

* Letter iv.

"It is in the power, indeed, of but a very small portion of mankind to act the same glorious part that afforded such high satisfaction to this distinguished patriot; but the number is yet far more inconsiderable of those who cannot, in any station, secure themselves a sufficient fund of complacency to render life justly valuable. Who is it that is placed out of the reach of the highest of all gratifications, those of the generous affections, and that cannot provide

A 2 for

Suicide.

16 Unnecessary to enter into the arguments of casuists upon this subject.

It is unnecessary then to enter particularly into the arguments of those casuists who have undertaken the despicable office of advocates for the crime of suicide. Their talents might surely have been employed more usefully to the world, and more honourably to themselves, than in pleading for a crime, which, if it were committed by every man to whom their principles would make it lawful, would totally destroy some of the noblest virtues, fortitude, patience, and resignation; nay, would destroy society itself, and teach us to despise the opinion that this world is a state of preparation for another. "I came into life without my own consent, and may I not quit it at pleasure?" (say the advocates for suicide). If, because we came into life without our own consent, we might quit it at pleasure, why may we not spend our life also as we please? Why may we not rob and murder, and commit every kind of crime, if *mere inclination* is to be the rule of action! Thus upon the principles of suicide the highwayman and murderer may reason, and every man may find a sufficient apology for any crime which he is tempted to commit. Or this absurdity may be otherwise answered: As we came into life without our own consent, we must have come with the consent of some other being; and logic says, that with the consent of that Being only can we lawfully quit it.

17 Its great criminality and imprudence.

It is sufficient shortly to say, that suicide is contrary to the strongest principle of the human constitution, self-preservation; that it is rebellion against God; that it is cruelty to the feelings and reputation, and often takes away the subsistence of a wife, a child, or a father; that it proves a want of fortitude to brave misfortunes; that it delivers only from imagined to plunge into real evils. We may add, that almost every instance of suicide of which we have heard was rash, imprudent, and premature, interrupted a useful life, or prevented a more honourable death. Had Cato's pride permitted him to yield himself to the generosity of Cæsar, his character and his influence might have contributed to retard the slavery of his country, which his death tended to hasten. Had Brutus and Cassius not executed the fatal resolution which they had formed, of dying by their own hands in case of misfortune, the battle of Philippi might have had a very different issue. Had Hannibal surrendered himself to the Romans, instead of swallowing poison, he would have gained more glory in braving their tortures than he won in the battle of Cannæ; for to die innocently and heroically is the greatest exertion of human fortitude.

18 How punished by the Greeks, Ceans, &c.

As suicide was deemed a crime by the most illustrious and virtuous of the Greek and Roman philosophers, it was considered as a crime by the laws, and treated with ignominy. By the law of Thebes suicides were to have no honours paid to their memory *. The Athenian law ordained the hand which committed the deed to be cut off, and burnt apart from the rest of the body. The body was not buried with the usual solemnities, but was ignominiously thrown into some pit. In Cea and Massilia (the ancient *Marseilles*), it was considered as a crime against the state; and it was therefore necessary for those who wished to destroy themselves to obtain permission from the magistrates. † Plutarch acquaints us, that an unaccountable passion for suicide seized the Milesian virgins; from indulging which they could not be prevented by the tears and entreaties of parents and friends: but what persuasion and entreaty could not effect was accomplished by very different means. A decree was issued, "that the body of every young woman who hanged herself should be dragged naked through the streets by the same rope with which she had committed the deed." This wise edict put a complete stop to the extraordinary frenzy, and suicide was no longer committed by the virgins of Miletus.

* *Petite Comment. in Leges Atticas*, p. 523.

† *Plutarch on the Virtues of Women.*

19 By the Romans.

In the early part of the Roman history there seems to have been seldom occasion for framing any laws against suicide. The only instance recorded occurs in the reign of Tarquinius Priscus. The soldiers who were appointed to make drains and common sewers, thinking themselves disgraced by such servile offices, put themselves to death in great numbers. The king ordered the bodies of all the self-murderers to be exposed on crosses, and this put an effectual stop to the practice. It is doubtful whether there was any standing law against suicide during the existence of the republic; but during the reign of the emperors it was thought proper to lay it under certain regulations, though not absolutely to condemn it as a crime. In Justinian's Digests there is a law, by which it was enacted, "that if persons accused, or who had been found guilty, of any crime, should make away with themselves, their effects should be confiscated." But this punishment only took place when confiscation of goods happened to be the penalty appointed by the law for the crime of which the self-murderer was accused or found guilty, and was not inflicted for suicide committed in any other circumstances.

Lib. xlviii. Tit. xxi. par. 3.

20 And by Christians.

When the Christian church had extended its jurisdiction in the Roman empire, it was decreed in the sixth century, that no commemoration should be made in the eucharist for such as destroyed themselves: neither should their

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for his own happiness, by contributing something to the welfare of others? As this disease of the mind generally breaks out with the most violence in those who are supposed to be endowed with a greater delicacy of taste and reason than is the usual allotment of their fellow creatures, one may ask them, whether there is any satiety in the pursuits of useful knowledge? or, if one can ever be weary of benefiting mankind? Will not the fine arts supply a lasting feast to the mind; or, can there be wanting a pleasureable enjoyment, so long as there remains even one advantageous truth to be discovered or confirmed? To complain that life has no joys, while there is a single creature whom we can relieve by our bounty, assist by our counsels, or enliven by our presence, is to lament the loss of that which we possess, and is just as rational as to die for thirst with the cup in our hands. But the misfortune is, when a man is settled into a habit of receiving all his pleasures from the mere selfish indulgences, he wears out of his mind the relish of every nobler enjoyment, at the same time that his powers of the sensual kind are growing more languid by each repetition. It is no wonder, therefore, he should fill up the measure of his gratifications long before he has completed the circle of his duration; and either wretchedly sit down the remainder of his days in discontent, or rashly throw them up in despair."

Suicide || Suit.

their bodies be carried out to burial with psalms, nor have the usual service said over them. This ecclesiastical law continued till the reformation, when it was admitted into the statute code of England by the authority of parliament. As an additional punishment, however, confiscation of land and goods seems to have been adopted from the Danes, as we learn from Bracton *. At present the punishment consists in confiscating all the personal property of a *felo de se* for the use of the crown, and in excluding his body from interment in consecrated ground. The warrant of the coroner requires that the body should be buried in some public highway, and a stake driven through it to increase the ignominy.

* De Legibus et Consuetudinibus Angliæ, Lib iii. Tract. 11.

21 Difficult to devise a punishment that would be an effectual preventive.

To inquire into the prevalence and causes of crimes, in order to discover the most judicious methods of preventing them, is the duty of the Patriot and the Christian. Suicide, we find, is a common and an increasing evil: but it is a difficult matter to find an effectual remedy; for what motives can be held out sufficient to influence that man's mind who is deaf to the voice of nature speaking within him, and to the voice of nature's God declaring that he is stationed at a post which it is his duty to maintain? His reputation and property are indeed within the reach of the laws, his body may be treated with ignominy, and his property confiscated; but this punishment will not be a preventive, even if it could be always inflicted; and that it is seldom inflicted, though the laws have decreed it, is well known. The humanity of the present age disposes us to sympathise with the relations of the deceased, instead of demanding that the sentence of the law should be executed. It is a generally received opinion, and a just one, that punishments decreed by human laws should be directed only against such crimes as are injurious to society; but when it is hence inferred, that suicide ought not to be subject to the cognizance of human laws, every rule of logic is violated. There is no man, however mean in station and in talents, whose life may not, on some occasions, be useful to the community at large; and to conclude, that a person who fancies himself useless may therefore lawfully put a period to his life, is as false reasoning as it would be to conclude, that by killing a poor man, who lives on the public, we should perform an action not only innocent but meritorious, as we should thereby free society from one of its burdens.

SUIDAS, a Greek writer, according to some, flourished in the 11th century, under the reign of the emperor Alexius Comnenus; according to others, before the 10th century. He wrote in Greek an Historical and Geographical Dictionary or Lexicon; a work which, though not always strictly accurate, is nevertheless of great importance, as it contains many things taken from the ancients that are nowhere else to be found. The best edition of Suidas is that of Kuister, in Greek and Latin, with notes, printed in 3 vols. fol. which has been much improved by Toup.

LAPIS SUILLUS. See *Swine-Stone*, MINERALOGY *Index*.

SUIT, is used in different senses; as, 1. Suit of court, or suit-service, which is an attendance the tenant owes to his lord's court. 2. Suit-covenant, where a person has covenanted to do service in the court of the lord. 3. Suit-custom, which is where one and his ancestors have owed suit time out of mind. 4. It is used for a petition to the king or any person of dignity, where a lord distrains his tenant for suit, and none is due. In this case, the party may have an attachment against him to appear in the king's court.

Suit.

SUIT, in *Law*, the same with action. The Romans introduced pretty early set forms for actions and suits into their law, after the example of the Greeks; and made it a rule, that each injury should be redressed by its proper remedy only. "*Actiones*, (says the Pandects) *compositæ sunt quibus inter se homines disceptarent, quas actiones ne populus prout vellet institueret, certas solemnesque esse voluerunt.*" The forms of these actions were originally preserved in the books of the pontifical college as choice and inestimable secrets, till one Cneius Flavius, the secretary of Appius Claudius, stole a copy and published them to the people. The concealment was ridiculous: but the establishment of some standard was undoubtedly necessary to fix the true state of a question of right; lest, in a long and arbitrary process, it might be shifted continually, and be at length no longer discernible. Or, as Cicero expresses it, "*sunt jura, sunt formulæ, de omnibus rebus constitutæ, ne quis aut in genere injuriæ, aut in ratione actionis, errare possit. Expressæ enim sunt ex uniuscujusque damno, dolore, incommodo, calamitate, injuria, publicæ à pretore formulæ, ad quas privata lis accommodatur.*" And in the same manner Bracton, speaking of the original writs upon which all our actions are founded, declares them to be fixed and immutable, unless by authority of parliament. And all the modern legislators of Europe have found it expedient, from the same reasons, to fall into the same or a similar method. In England, the several suits, or remedial instruments of justice, are, from the subject of them, distinguished into three kinds; actions *personal*, *real*, and *mixed*.

Blackst. Comment.

Personal actions are such whereby a man claims a debt, or personal duty or damages, in lieu thereof; and likewise whereby a man claims a satisfaction in damages for some injury done to his person or property. The former are said to be founded upon contracts, the latter upon *torts* or wrongs: and they are the same which the civil law calls, "*actiones in personam, quæ adversus eum intenduntur qui ex contractu vel delicto obligatus est aliquid dare vel concedere.*" Of the former nature are all actions upon debt or promises; of the latter are all actions of trespasses, nuisances, assaults, defamatory words, and the like.

Real actions (or, as they are called in the Mirror, *feodal actions*), which concern real property only, are such whereby the plaintiff, here called the *demandant*, claims title to have any lands or tenements, rents, commons, or other hereditaments, in fee-simple, fee-tail, or for term of life. By these actions formerly all disputes concerning real estates were decided; but they are now pretty generally laid aside in practice, upon account of the great nicety required in their management, and the inconvenient length of their process; a much more expeditious method of trying titles being since introduced, by other actions personal and mixed.

Mixed actions are suits partaking of the mixture of the other two, wherein some real property is demanded, and also personal damages for a wrong sustained. As for instance, an action of waste; which is brought by him who hath the inheritance, in remainder or reversion, against the tenant for life, who hath committed waste therein,

therein, to recover not only the land wasted, which would make it merely a real action; but also treble damages, in pursuance of the statute of Gloucester, which is a personal recompense; and so both, being joined together, denominate it a *mixed action*.

The orderly parts of a suit are these: 1. The original *writ*. 2. The *process*. 3. The *pleadings*. 4. The *issue* or demurrer. 5. The *trial*. 6. The *judgment* and its incidents. 7. The proceedings in nature of *appeals*. 8. The *execution*. See these articles.

SULLY. See BETHUNE.

SULPHATE, in *Chemistry*, denotes a compound of sulphuric acid with some base.

SULPHUR, a well known inflammable substance. See CHEMISTRY and MINERALOGY *Index*.

SULPHUR-Wort. See PEUCEDANUM, BOTANY *Index*.

SULPHURIC ACID, the name now adopted for the vitriolic acid. See CHEMISTRY *Index*.

SULPICIA, an ancient Roman poetess, who lived under the reign of Domitian, and has been so much admired as to be termed the *Roman Sappho*. We have nothing, however, left of her writings but a satire, or rather the fragment of one, against Domitian, who published a decree for the banishment of philosophers from Rome; which satire is to be found in Scaliger's *Appendix Virgiliana*. She is mentioned by Martial and Sidonius Apollinaris; and is said to have addressed a poem on conjugal love to her husband Calenus, a Roman knight.

SULPICIUS SEVERUS, an ecclesiastical writer who flourished about the beginning of the 5th century, and was contemporary with Rufinus and St Jerome. He was the disciple of St Martin of Tours, whose life he has written; and the friend of Paulinus bishop of Nola, with whom he held an intimate correspondence. The principal of his works is his *Historia Sacra*, from the creation of the world to the consulate of Stilicho and Aurelian, about the year 400; in which his style is elegant beyond the age he lived in.

SULTAN, or SOLDAN, a title of appellation given to the emperor of the Turks.

Vatner will have the word Turkish, and to signify *king of kings*; adding, that it was first given to the Turkish princes Angrolipex and Masgud, about the year 1055: others will have it originally Persian, alleging, in proof hereof, an ancient medal of Cosroe; others derive it from *soldanus, quasi solus dominus*; others from the Hebrew שלט, *schalat* or *sheleth*, "to rule, reign."

It had its rise under Mahmoud, son of Sebecteghin, the first emperor of the dynasty of the Gaznevides, towards the close of the fourth century of the era of the Hegira: when that prince going to Segestan to reduce Kalaf governor of that province, who affected the sovereignty, Kalaf was no sooner advertised of his coming than he went out to meet him, delivered the keys of his fortress, and owned him his *sultan*, that is, his lord or commander. The title pleased Mahmoud so well, that he assumed it ever afterwards; and from him it passed to his descendants, and to other Mahometan princes. It is chiefly confined to the Turkish and Persian monarchs.

SULZER, M. a celebrated philosopher, was born at Winterthur, in the canton of Zurich, October 16. 1720. He was the youngest of 25 children. His early education did not promise much, though it was by no means neglected. He had little inclination for what i[s] called in the schools the study of *humanity*, and mad[e] but a small progress in the learned languages, whic[h] were to prepare him for the study of theology, for whic[h] profession his parents designed him. At the age of 16 when he went to the academical school of Zurich, h[e] had not the smallest notion of the sciences, or of elegan[t] literature, and consequently no taste for study. The firs[t] incident that developed a hidden germ of philosophica[l] genius, was his meeting with Wolfe's Metaphysics this was the birth of his taste for science: but he wante[d] a guide. The clergyman with whom he lodged was a[n] ignorant man; and the academical prelections were, a[s] yet, above the reach of his comprehension. On the othe[r] hand, a sedentary life was not the thing he liked, no[r] to which he had been accustomed; and, moreover, a sociable turn of mind led him often into company, wher[e] he lost much time in frivolous amusements, yet withou[t] corrupting his morals. Who, that observed him at thi[s] period, says Mr Formey in his *Eulogium*, would have thought that Sulzer would one day be numbered among the most knowing and wise men of his time? The learned Gesner was the instrument of Providence that rendered Sulzer's inclination to study triumphant over his passion for amusement and company. Animated by the counsels and example of this worthy and learned man, he applied himself to philosophy and mathematics with great ardour, and resumed the pursuit of Grecian literature and the oriental languages. The contemplation of nature became his noble and favourite passion. An ecclesiastical settlement in a rural scene, that exhibited happy objects and occasions for this delightful study, began to render his days happy and useful; and he published, in 1741, Moral Contemplations of the Works of Nature; and the year following an Account of a Journey he had made through the Alps; which showed at the same time, his knowledge of natural history, and the taste and sensibility with which he surveyed the beauties of nature and the grandeur and goodness of its Author. He afterwards became private tutor to a young gentleman at Magdeburg. This procured him the acquaintance of Messrs Maupertuis, Euler, and Sack, which opened to his merit the path of preferment, and advanced him successively to the place of mathematical professor in the King's College at Berlin, in 1747, and to that of member of the Royal Academy in 1750.

In this last quality he distinguished himself in a very eminent manner, enriched the class of speculative philosophy with a great number of excellent memoirs, and was justly considered as one of the first-rate metaphysicians in Germany. But his genius was not confined to this branch of science. His universal Theory of the Fine Arts is a valuable production. A profound knowledge of the arts and sciences, and a perfect acquaintance with true taste, are eminently displayed in this work, and will secure to its author a permanent and distinguished rank in the republic of letters. The first volume of this excellent work was published in 1771, and the second in 1774. We shall not here give a catalogue of the writings of M. Sulzer; but we cannot help mentioning his remarks on the Philosophical Essays of the late Mr Hume as a work of real merit, which does justice to the acuteness, while it often detects the sophistry, of the British Bayle. The moral character of M. Sulzer was amiable and virtuous; sociability and beneficence

cence were its characteristical lines; and his virtues were animated by that sacred philosophy that forms the Christian, ennobles man, and is the only source of that heart-felt serenity and sedate fortitude which support humanity, when every other object of confidence fails. His dying moments were calm, humble, and sublime; and when he expired, the placid and composed air of his countenance made his mourning friends doubt, for some time, whether it was death or sleep that had suspended his conversation. He had no enemy; and his friends were numerous, affectionate, and worthy of the tender returns he made them.

The king of Prussia distinguished him by repeated marks of munificence and favour. But his royal protector had never seen him before the end of the year 1777, though he had been member of the academy from the year 1750. The audience, indeed, though late vouchsafed, was honourable to M. Sulzer, with whom the monarch conversed for a long time with great condescension.

SUM, signifies the quantity that arises from the addition of two or more magnitudes, numbers, or quantities together.

SUMACH. See Rhus, Botany *Index*.

SUMATRA, an island of Asia, the most western of the Sunda islands, and constituting on that side the boundary of the Eastern Archipelago. Its general direction is nearly north-west and south-east. The equator divides it into almost equal parts, the one extremity being in 5. 53. N. and the other in 5. 56. S. Lat. Acheen Head, at the north extremity of the island, is in longitude 95. 34. east. It lies exposed on the south-west side to the Indian ocean; the north point stretches into the bay of Bengal; to the north-east it is divided from the peninsula of Malacca by the straits of that name; to the east by the straits of Banca, from the island of that name; to the south-east by the commencement of what are called the *Chinese seas;* and on the south by the straits of Sunda, which separate it from the island of Java. It is about 900 miles in length, but from 100 to 150 only in breadth. No account had been given of this island by any Englishman till the year 1778, when Mr Charles Miller (son of the late botanical gardener) published an account of the manners of a particular district, in the 68th volume of the Philosophical Transactions. These were the Battas, a people who live in the interior parts, called the *Cassia Country*. They differ from all the other inhabitants in language, manners, and customs. They eat the prisoners whom they take in war, and hang up their skulls as trophies in their houses. He observes, however, that human flesh is eaten by them *in terrorem*, and not as common food, though they prefer it to all others, and speak with peculiar raptures of the soles of the feet and palms of the hands. They expressed much surprise that the white people did not kill, much less eat, their prisoners. From this country the greatest part of the cassia that is sent to Europe is procured. It abounds also with the camphire trees, which constitute the common timber in use; and in these trees the camphire is found native, in a concrete form. It is remarkable that, in this state, it is sold to the Chinese at the price of 250l. or 300l. per cent.; but these dexterous artists contrive to furnish the Europeans with it at about a quarter of that price. In 1783, Mr Marsden, who had been secretary to the president and council of Fort Marlborough, published a

Brooke's Gazetteer.

History of Sumatra, with very copious particulars of the island. He represented it as surpassed by few in the beautiful indulgences of nature. A chain of high mountains runs through its whole extent; the ranges in many parts being double and treble; their altitude, though great, is not sufficient to occasion their being covered with snow during any part of the year. Between these ridges are extensive plains, considerably elevated above the surface of the maritime lands. In these the air is cool; and from this advantage they are esteemed the most eligible portion of the country, are the best inhabited, and the most cleared from woods, which elsewhere, in general, throughout Sumatra, cover both hills and valleys with an eternal shade. Here too are found many large and beautiful lakes, that facilitate much the communication between the different parts. The heat of the air is far from being so intense as might be expected from a country occupying the middle of the torrid zone; and it is more temperate than many regions within the tropics; the thermometer at the most sultry hour, about two in the afternoon, generally fluctuating between 82 and 85 degrees. Mr Marsden divides the inhabitants into Malays, Achenese, Battas, Lampoons, and Rejangs; and he takes the latter as his standard of description, with respect to the persons, manners, and customs, of the inhabitants. They are rather below the middle stature; their bulk in proportion; their limbs for the most part slight, but well shaped, and particularly small at the wrists and ancles; and, upon the whole they are gracefully formed. Their hair is strong, and of a shining black. The men are beardless, great pains being taken to render them so when boys, by rubbing their chins with a kind of quicklime. Their complexion is properly yellow, wanting the red tinge that constitutes a copper or tawney colour. They are in general lighter than the Mestees, or half-breed, of the rest of India; those of the superior class, who are not exposed to the rays of the sun, and particularly their women of rank, approaching to a degree of fairness. If beauty consisted in this one quality, some of them would surpass our brunettes in Europe. The major part of the females are ugly, many of them even to disgust; yet among them are some whose appearance is strikingly beautiful, whatever composition of person, features, and complexion, that sentiment may be the result of. Some of the inhabitants of the hilly parts are observed to have the swelled neck or goitre; but they attempt no remedy for it, as these wens are consistent with the highest health. The rites of marriage among the Sumatrans consist simply in joining the hands of the parties, and pronouncing them man and wife without much ceremony, excepting the entertainment which is given upon the occasion by the father of the girl. The customs of the Sumatrans permit their having as many wives as they can purchase, or afford to maintain; but it is extremely rare that an instance occurs of their having more than one, and that only among a few of the chiefs. This continence they owe, in some measure, to their poverty. The dictates of frugality are more powerful with them than the irregular calls of appetite, and make them decline an indulgence from which their law does not restrain them. Mothers carry their children, not on the arm as our nurses do, but straddling on the hip, and usually supported by a cloth which ties in a knot on the opposite shoulder. The children are nursed but little; are not confined

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confined by any swathing or bandages; and being suffered to roll about the floor, soon learn to walk and shift for themselves. When cradles are used, they swing suspended from the ceilings of the rooms.

The Sumatrans are so fond of cock-fighting, that a father on his death-bed has been known to desire his son to take the first opportunity of matching a cock for a sum equal to his whole property, under a blind conviction of its being invulnerable. When a cock is killed or runs, the other must have sufficient spirit and vigour left to peck at him three times on his being held up to him for that purpose, or it becomes a drawn battle; and sometimes an experienced cocker will place the head of his vanquished bird in such an uncouth situation as to terrify the other, and render him unable to give this proof of victory.

The wild beasts of Sumatra are tigers, elephants, rhinoceroses, bears, and monkeys. The tigers prove to the inhabitants both in their journeys and even their domestic occupations most destructive enemies. The number of people annually slain by these rapacious tyrants of the woods is almost incredible. Whole villages have been depopulated by them; yet from a superstitious prejudice, it is with difficulty they are prevailed upon, by a large reward which the India Company offers, to use methods of destroying them, till they have sustained some particular injury in their own family or kindred. The size and strength of the species which prevails on this island is prodigious. They are said to break with a stroke of their fore paw the leg of a horse or a buffalo; and the largest prey they kill is without difficulty dragged by them into the woods. This they usually perform on the second night, being supposed on the first to gratify themselves with sucking the blood only. Time is by this delay afforded to prepare for their destruction, either by shooting them, or placing a vessel of water strongly impregnated with arsenic near the carcase, which is fastened to a tree to prevent its being carried off. The tiger having satiated himself with the flesh, is prompted to assuage his thirst with the tempting liquor at hand, and perishes in the indulgence. Their chief subsistence is most probably the unfortunate monkeys with which the woods abound. They are described as alluring them to their fate by a fascinating power, similar to what has been supposed of the snake; and, says Mr Marsden, "I am not incredulous enough to treat the idea with contempt, having myself observed, that when an alligator or a crocodile, in a river, comes under an overhanging branch of a tree, the monkeys, in a state of alarm and distraction, crowd to the extremity, and, chattering and trembling, approach nearer and nearer to the amphibious monster that waits to devour them as they drop, which their fright and number render almost unavoidable." These alligators likewise occasion the loss of many inhabitants, frequently destroying the people as they bathe in the river, according to their regular custom, and which the perpetual evidence of the risk attending it cannot deter them from. A superstitious idea of their sanctity also preserves them from molestation, although, with a hook of sufficient strength, they may be taken without much difficulty. The other animals of Sumatra are buffaloes, a small kind of horses, goats, hogs, deer, bullocks, and hog-deer. This last is an animal somewhat larger than a rabbit, the head resembling that of a hog, and its shanks and feet like those of the deer. The bezoar-stone found on this animal [h]as been valued at 10 times its weight in gold; it is of [a] dark brown colour, smooth on the outside; and [the] coat being taken off, it appears still darker, with strie[s] running underneath the coat: it will swim on the top [of] the water. If it be infused in any liquid, it makes [it] extremely bitter: the virtues usually attributed to th[is] stone are cleansing the stomach, creating an appeti[te,] and sweetening the blood.

Of birds they have a greater variety than of beas[ts.] The coo-ow, or Sumatran pheasant, is a bird of uncom[mon] beauty. They have storks of prodigious size, pa[r]rots, dung-hill fowls, ducks, the largest cocks in th[e] world, wood-pigeons, doves, and a great variety of sma[ll] birds, different from ours, and distinguished by the beau[ty] of their colours. Of the reptiles, they have lizard[s,] flying lizards, and cameleons. The island swarms wit[h] insects, and their varieties are no less extraordinary tha[n] their numbers. Rice is the only grain that grows in th[e] country; they have sugar-canes, beans, pease, radishes, yams, potatoes, pumkins, and several kinds of pot-herb[s] unknown to Europe; and here are to be found most o[f] the fruits to be met with in other parts of the East In[]dies, in the greatest perfection. Indigo, Brasil-wood, two species of the bread-fruit tree, pepper, benjamin, coffee and cotton, are likewise the produce of this island, as well as cassia and camphire mentioned above. Her[e] also is the cabbage-tree and silk-cotton tree; and the forests contain a great variety of valuable species o[f] wood, as ebony, pine, sandal, eagle or aloes, teek, manchineel, and iron-wood, and also the banyan tree. Gold, tin, iron, copper, and lead, are found in the country; and the former is supposed to be as plentiful here as in Peru or Mexico. The finest gold and gold-dust are found in the country of *Limong*, immediately contiguous to the presidency of *Fort Marlborough*, to which the merchants repair annually for the purchase of opium, and such other articles as they may be in want of, and give for them gold of so pure a nature as to contain little or no alloy. The native indolence of the *Malay* disposition prevents them from collecting more than is sufficient to supply the few and simple wants of a race of men as yet unenlightened by civilization and science, and ignorant of the full extent of the advantages of the country inhabited by them. The roads leading to this golden country are almost impervious; affording only a scanty path to a single traveller, where whole nights must be passed in the open air, exposed to the malignant influence of a hostile climate, in a country infested by the most ferocious wild beasts. These are circumstances that have hitherto checked curiosity; but perseverance and studied precaution will surmount the obstacles they furnish, and such discoveries might be made as would amply compensate for the difficulties leading to them. The gold merchants who come from the neighbouring and less rich countries, give us such accounts of the facility of procuring gold as border nearly on the marvellous, and would be altogether incredible, if great quantities of that metal produced by them did not in some degree evince the certainty of their accounts.

This great abundance of gold in Sumatra induces Mr Marsden to suppose that island to be the Ophir of Solomon; a conjecture which, in his opinion, derives no small force from the word *Ophir* being really a *Malay* substantive, of a compound sense, signifying a mountain containing

containing gold. The natives, he confesses, have no oral tradition on the subject; and we have elsewhere made it probable that Ophir was situated in a different quarter of the world (see OPHIR). Besides the metals and different species of wood which we have mentioned, Sumatra produces sulphur, arsenic, saltpetre, and bees-wax, with edible birds-nests, which are there commodities of great importance (see *Birds-Nests*).

The English and Dutch have factories on this island; the principal one of the former being Fort Marlborough, on the south-west coast. The original natives of Sumatra are Pagans; but it is to be observed, that when the Sumatrans, or any of the natives of the eastern islands, learn to read the Arabic character, and submit to circumcision, they are said to become Malays; the term *Malay* being understood to mean *Mussulman*. See ACHEEN.

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SUMMARY, in matters of literature. See ABRIDGEMENT.

SUMMER, the name of one of the seasons of the year, being one of the quarters when the year is divided into four quarters, or one half when the year is divided only into two, summer and winter. In the former case, summer is the quarter during which, in northern climates, the sun is passing through the three signs Cancer, Leo, Virgo, or from the time of the greatest declination, till the sun come to the equinoctial again, or have no declination; which is from about the 21st of June till about the 22d of September. In the latter case, summer contains the six warmer months, while the sun is on one side of the equinoctial; and winter the other six months, when the sun is on the other side of it. It is said that a frosty winter produces a dry summer, and a mild winter a wet summer.

Summer-Islands. See BERMUDAS.

Summer Red-Bird. See MUSCICAPA, ORNITHOLOGY *Index*.

SUMMIT, the top or vertex of any body or figure, as of a triangle, cone, pyramid, &c.

SUMMONS, in *Law*, a citing or calling a person to any court, to answer a complaint or to give his evidence.

SUMMONS, in *War*. To summon a place is to send a drum or trumpet to command the governor to surrender, and to declare that if the place be taken by storm, all must submit to the mercy of the conqueror. See CAPITULATION and CHAMADE.

SUMMUM BONUM, in *Ethics*, the chief good.

SUMP, in *Metallurgy*, a round pit of stone, lined with clay within, for receiving the metal on its first fusion from the ore.

SUMP, in the British salt-works, where sea-water is boiled into salt, is the name of a sort of pond, which is made at some distance from the saltern on the sea-shore, between full sea and low-water mark. From this pond a pipe is laid, through which, when it is full sea, the water runs into a well adjoining to the saltern; and from this well it is pumped into troughs, through which it is carried to the cisterns, in order to be ready to supply the pans. See SALT.

SUMP, in *Mining*, denotes a pit sunk down in the bottom of the mine, to cut or prove the lode still deeper than before; and in order to slope and dig it away if necessary, and also to drive on the lode in depth. The sump principally serves as a bason or reservoir, to collect the water of a mine together, that it may be cleaned out by an engine or machine.

SUMPTER HORSE, is a horse that carries provisions and necessaries for a journey.

SUMPTUARY LAWS (*Leges Sumptuariæ*), are laws made to restrain excess in apparel, costly furniture, eating, &c.

Most ages and nations have had their sumptuary laws; and some retain them still, as the Venetians, &c. But it is observed that no laws are worse executed than sumptuary laws. Political writers have been much divided in opinion with respect to the utility of these laws to a state. Montesquieu observes that luxury is necessary in monarchies, as in France, but ruinous to democracies, as in Holland. With regard to England, whose government is compounded of both species, it may still be a dubious question, says Judge Blackstone, how far private luxury is a public evil; and as such cognizable by public laws.

The sumptuary laws of the ancient Locrian legislator Zaleucus are famous: by these it was ordained that no woman should go attended with more than one maid in the street except she were drunk: that she should not go out of the city in the night, unless she went to commit fornication: that she should not wear any gold or embroidered apparel, unless she proposed to be a common strumpet; and that men should not wear rings or tissues except when they went a whoring, &c.

Among the Romans, the sumptuary laws were very numerous: By the *Lex Orchia*, the number of guests at feasts was limited, though without any limitation of the charges: by the Fannian law, made 22 years afterwards, it was enacted, that more than 10 *asses* should not be spent at any ordinary feast: for the solemn feasts, as the Saturnalia, &c. an hundred asses were allowed; ten of which, Gellius informs us, was the price of a sheep, and a hundred of an ox. By the Didian law, which was preferred 18 years after, it was decreed, that the former sumptuary laws should be in force, not only in Rome, but throughout all Italy; and that for every transgression, not only the master of the feast, but all the guests too, should be liable to the penalty.

The English have had their share of sumptuary laws, chiefly made in the reigns of Edward III. Edward IV. and Henry VIII. against shoes with long points, short doublets, and long coats; though all repealed by statute 1 Jac. I. c. 25. As to excess in diet, there remains still one law unrepealed. Under King Henry IV. Camden tells us, pride had got so much into the foot, that it was proclaimed, that no man should wear shoes above six inches broad at the toes. And their outer garments were so short, that it was enacted, 25 Edward IV. that no person, under the condition of a lord, should from that time, wear any mantle or gown, unless of such length, that standing upright, it might cover the lower part of the trunk of his body.

SUN, SOL, ☉, in *Astronomy*, the great luminary which enlightens the world, and by its presence constitutes day. See ASTRONOMY *Index*.

Mock-Sun. See PARHELION.

Sun-Fish, a species of shark. See SQUALUS, ICHTHYOLOGY *Index*.

Sun-Flower. See HELIANTHUS, } BOTANY *Index*.
Sun-Dew. See DROSERA, }

SUNDA-ISLANDS, a general name for a cluster of islands

islands in the Indian ocean, between 93° and 120° of east longitude, and between 8° north and 8° south latitude. The particular names of the islands are *Borneo*, *Sumatra*, *Java*, *Bally*, *Banca*, &c.

SUNDAY, or the LORD'S-DAY, a solemn festival observed by Christians on the first day of every week, in memory of our Saviour's resurrection. See SABBATH.

In the breviary and other offices we meet with Sundays of the first and second class. Those of the first class are, Palm, Easter, Advent, and Whitsunday, those of *Quasimodo* and *Quadragesima*. Those of the second class are the common Sundays. Anciently each Sunday in the year had its particular name, which was taken from the introit of the day; which custom has only been continued to some few in lent; as *Reminiscere*, *Oculi*, *Lætare*, *Judica*.

Some are of opinion that the Lord's day, mentioned in the Apocalypse, is our Sunday; which they believe was so early instituted by the apostles. Be this as it will, it is certain a regard was had to this day even in the earliest ages of the church; as appears from the first apology of Justin Martyr, where he describes the exercise of the day not much unlike to ours.

But it was Constantine the Great who first made a law for the proper observation of Sunday; and who, according to Eusebius, appointed it should be regularly celebrated throughout the Roman empire. Before him, and even in his time, they observed the Jewish Sabbath as well as Sunday; both to satisfy the law of Moses and to imitate the apostles, who used to meet together on the first day.

By Constantine's laws, made in 321, it was decreed, that for the future the Sunday should be kept a day of rest in all cities and towns; but he allowed the country people to follow their work. In 538, the council of Orleans prohibited country labour; but because there were still many Jews in Gaul, and the people fell into many superstitious uses in the celebration of the new Sabbath, like those of the Jews among that of the old, the council declares, that to hold it unlawful to travel with horses, cattle, and carriages, to prepare food, or to do any thing necessary to the cleanliness and decency of houses or persons, savours more of Judaism than of Christianity. See SABBATH-*Breaking*.

SUNDAY-*Schools*. See *Sunday*-SCHOOLS.

SUOVETAURILIA, an ancient Roman sacrifice, so called because it consisted of a pig (*sus*), a sheep or rather ram (*ovis*), and a bull (*taurus*). They were all males, to denote the masculine courage of the Roman people. It was likewise called *solitaurilia*, because the animals offered up were always *solida*, whole or uncut.

SUPERCARGO, a person employed by merchants to go a voyage, and oversee their cargo or lading, and dispose of it to the best advantage.

SUPERCILIUM, in *Anatomy*, the eye-brow. See ANATOMY, N° 142.

SUPEREROGATION, in *Theology*, what a man does beyond his duty, or more than he is commanded to do. The Romanists stand up strenuously for works of supererogation, and maintain that the observance of evangelical councils is such. By means hereof, a stock of merit is laid up, which the church has the disposal of, and which she distributes in indulgences to such as need. This absurd doctrine was first invented towards the close of the 12th century, and modified and embell[...] by St Thomas in the 13th: according to which, it [...] pretended that there actually existed an immense [...] sure of merit, composed of the pious deeds and virt[...] actions which the saints had performed beyond what [...] necessary for their own salvation, and which were th[...] fore applicable to the benefit of others; that the g[...] dian and dispenser of this precious treasure was [...] Roman pontiff; and that of consequence he was [...] powered to assign to such as he thought proper a [...] tion of this inexhaustible source of merit, suitable to t[...] respective guilt, and sufficient to deliver them from [...] punishment due to their crimes.

The reformed churches do not allow of any work[...] supererogation; but hold with the apostles, that wh[...] we have done our best, we are but unprofitable serva[...]

SUPERFETATION, in *Physiology*, a second after-conception, happening when the mother, alrea[...] pregnant, conceives of a latter coition; so that she be[...] at once two fœtuses of unequal age and bulk, and is [...] livered of them at different times. We meet with [...] stances of superfetations in Hippocrates, Aristotle, [...] Laurens, &c.: but they are said to be much more fr[...] quent in hares and swine.

SUPERFICIES, or SURFACE, in *Geometry*, the ou[...] side or exterior face of any body. This is considered having the two dimensions of length and breadth onl[...] but no thickness; and therefore it makes no part of t[...] substance or solid content or matter of the body.

The terms, or bounds, or extremities, of a superficie[...] are lines; and superficies may be considered as genera[...] ed by the motions of lines. Superficies are either rect[...] linear, curvilinear, plane, concave, or convex. A recti[...] linear superficies is that which is bounded by right line[...] Curvilinear superficies is bounded by curve lines. Plan[...] superficies is that which has no inequality in it, nor ri[...] sings, nor sinkings, but lies evenly and straight through[...] out, so that a right line may wholly coincide with it in all parts and directions. Convex superficies is that which is curved and rises outwards. Concave superficies is curved and sinks inward. See GEOMETRY.

SUPERFINE, in the manufactories, a term used to express the superlative fineness of a stuff: thus a cloth, a camblet, &c. are said to be superfine when made of the finest wool, &c. or when they are the finest that can be made.

SUPERFLUOUS INTERVAL, in *Music*, is one that exceeds a true diatonic interval by a semitone minor. See INTERVAL.

SUPERINTENDANT, denotes an ecclesiastical superior in several reformed churches where episcopacy is not admitted; particularly among the Lutherans in Germany, and the Calvinists in some other places.

The superintendant is similar to a bishop; only his power is somewhat more restrained than that of our diocesan bishops. He is the chief pastor, and has the direction of all the inferior pastors within his district or diocese. In Germany they had formerly superintendants general, who were superior to the ordinary superintendants. These, in reality, were archbishops; but the dignity is sunk into disuse; and at present none but the superintendant of Wirtemberg assumes the quality of superintendant general.

SUPERIOR, a person raised above another in rank, office, or talents.

Superior ‖ Superstition.

SUPERIOR, in *Scots Law*. See LAW, N° clxiv. 3. clxv. 2. and clxvi.

SUPERLATIVE, in *Grammar*, one of the three degrees of comparison, being that inflection of adjective nouns that serves to augment and heighten their signification, and shows the quality of the thing denoted to be in the highest degree. See GRAMMAR.

SUPERNUMERARY, something over and above a fixed number. In several of the offices are supernumerary clerks, to be ready on extraordinary occasions.

SUPERPARTICULAR PROPORTION, or *Ratio*, is that in which the greater term exceeds the less by unit or 1. As the ratio of 1 to 2, or 2 to 3, or 3 to 4, &c.

SUPERPARTIENT PROPORTION, or *Ratio*, is when the greater term contains the less term once, and leaves some number greater than 1 remaining. As the ratio

of 3 to 5, which is equal to that of 1 to $1\frac{2}{3}$;
of 7 to 10, which is equal to that of 1 to $1\frac{3}{7}$, &c.

SUPERSEDEAS, in *Law*, a writ issued in divers cases, importing in general a command to stay or forbear some ordinary proceedings in law, which in appearance ought to be done or pursued, were it not for the cause whereon this writ is granted.

Thus a man regularly is to have a surety of peace against him of whom he will swear he is afraid; and the justice required hereunto cannot deny it him: yet, if the party be formerly bound to the peace, either in chancery or elsewhere, this writ lies to stay the justice from doing that which otherwise he ought not to deny.

SUPERSTITION, a word that has been used so indefinitely, that it is difficult to determine its precise meaning. From its resemblance in sound to the Latin word *superstes*, "a survivor," it is evidently derived from it, and different attempts have been made to trace their connection in signification. Balbus, in the dialogue *De Natura Deorum* of Cicero, says, that they who prayed and sacrificed whole days that their children might *survive* them, were called superstitious. Lactantius censures this etymology, and says they were not called superstitious who wished that their children might survive them (for this we all wish), but because they who survived their parents worshipped their images. Others again say, that superstition is derived from *superstes*, because it consisted in considering the dead as if they were alive. But these etymologies are solely conjectural; and we consider conjectures as absurd in philology as we do in science; they may mislead, but are seldom of any benefit. The usual meaning affixed to the word *superstition*, both in the Latin and English languages, is so different from *superstes*, that its change of meaning must be owing to some accident which it is in vain to inquire after. If we had not known that the word *paganus*, "a pagan," was derived from *pagus*, "a village," because the heathens in a certain period of the Christian history lived in villages, the whims and fancies of etymologists would not have thrown much light on the subject.

Without labouring, from the aid of etymology, to define superstition, which is a word of a very extensive signification, we will consider to what objects it is applied; and then, by observing what is common to them all, we shall be enabled to fix with some degree of precision the meaning of the term. We apply it to the idolatry of the heathens; we apply it also to the Jews, who made the will of God of no effect by their traditions, and substituted ceremonies in place of the religion of their fathers. We say also that Christians are guilty of superstition; the Roman Catholics, who believe in transubstantiation and in the efficacy of prayers to saints; and those Protestants who esteem baptism and the Lord's supper, and the punctual performance of other ceremonies, without regard to morality, as sufficient to ensure salvation. Those persons are also reckoned superstitious who believe, without any evidence, that prophecies are still uttered by the divine inspiration, and that miracles are still performed. The word is also extended to those who believe in witchcraft, magic, and apparitions, or that the divine will is declared by omens or augury; that the fortune of individuals can be affected by things indifferent, by things deemed lucky or unlucky, or that diseases can be cured by words, charms, and incantations.

Through all the particulars which we have enumerated, there runs one general idea, the belief of what is false and contrary to reason. From this, however, we must not suppose that whatever is false and contrary to reason may be denominated superstition. We think that it is false and irrational to suppose that there ever lived on earth a race of men who walked on one leg, and had their eyes in their breast; or that there were giants 90 feet high: yet we do not call the philosopher who believes these chimeras superstitious, but credulous. Superstition has always a reference to God, to religion, or to beings superior to man. We do not however distinguish all false and irrational opinions in religion by the name of superstition. We do not, for instance, apply this name to the opinions which some of the ancients entertained, that God is the soul of the world, and that men are only portions of him separated for a time, or that the soul after death lives successively in different bodies. If we examine the subject with more attention, we shall discover that the foundation of superstition is ignorance of the moral attributes of God; for we never say a man is superstitious for entertaining erroneous opinions of the natural attributes of God. Some of the Socinians have denied the prescience of God; and a French philosopher has not only rejected the belief that He is a spirit, but has presumed to say that he is composed of a species of crystals. The first of these opinions discovers very imperfect ideas of God, and the second is the height of impiety and absurdity; yet the Socinians have not been accused of superstition, nor can this French philosopher be suspected of it. We do not call every false opinion concerning the unity or moral attributes of God by the name of superstition, as, for instance, the opinion which some sceptics have supported, that God is not good; for, as was mentioned before, superstition always involves the idea of credulity. It does not consist in falsely denying that God possesses any particular moral attributes, but in believing more than what is true concerning them; in forming mean, unworthy ideas of them; in supposing that he is guided by blind passion like mankind, and enjoins upon his creatures commandments which are irrational and absurd.

As superstition arises from ignorance and credulity in the understanding, so it has also a seat in the passions. Fear has been commonly considered as a passion of the human mind from which it chiefly derives its origin;

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and there is no doubt that more superstition has arisen from fear united with ignorance and credulity than from any other passion. Yet it would certainly be improper to exclude all other passions. We cannot account for the superstition of the Egyptians, without supposing that much of it arose from gratitude. They worshipped the Nile, because it distributed fertility and abundance over the land of Egypt; and they worshipped some animals, merely because they prevented the increase of other animals which were noxious. Thus they adored the ibis, because it destroyed the eggs of the crocodile.

Having thus endeavoured to analyze the ideas comprehended under the word superstition, we may sum them up in a few words. It respects God and beings superior to man, and extends to our religious opinions, worship, and practices; and may be defined *absurd opinions and actions arising from mean and defective ideas of the moral attributes of God.* Let us apply this definition to the different species of superstition already mentioned.

But before entering upon this application, it may be proper to observe, that superstition involves the idea of a blameable inattention to reason, or a credulity arising from an indolence of understanding. We generally make a distinction between the imperfect opinions which a savage, from the necessary effects of his situation, forms of the attributes of God, and those which civilized nations entertain. We say the savage is ignorant, and we ascribe his ignorance to his situation; but we call the Roman Catholic superstitious, and we blame him for not having those just ideas of God which he might have obtained by opening his Bible, or by the exercise of his understanding in the favourable situation in which he is placed. Superstition then does not originate so much from the natural weakness of the human understanding, as from a misapplication or a neglect of it (A).

We cannot therefore with any propriety apply the name *superstition* to polytheism in general; for what all the ancient philosophers, after much study and reflection, concluded to be true, could never proceed from credulity and inattention, but from their situation. We speak very properly, however, when we call idolatry by the name of superstition; because there is no man so devoid of understanding as not to be capable of discovering, that a piece of metal, or wood, or stone, can neither hear nor answer petitions. *Superstition* was a name which the ancient philosophers gave to those who entertained mean opinions of the gods, or did foolish things to obtain their favour. According to Theophrastus, the superstitious man is one who, having washed his hands, and sprinkled himself all round, leaves the temple with a laurel leaf in his mouth, with which he walks about the whole day. Or, if a weasel should cross the road, he will not advance a step till he has thrown three stones over the road. If he find a serpent in his house, he rears a place of devotion on the spot. He purifies his house often, will not sit upon a grave, or touch a dead person. He is anxious about the interpretation of his dreams, will not offer a sacrifice unless his wife go along with him, or, if she is engaged, he takes the nurse

Theophrastus's Characters, xvi.

and the little children. He purifies himself with onions; and when he sees a mad or an epileptic person, he spits in their bosom. Such was the character of superstition in the days of Theophrastus. All these whimsical ceremonies were done to prevent mischief, and to avert the wrath of the gods; and therefore perfectly correspond with the definition given above.

It is only necessary to consider a little the superstitious opinions and practices among Jews and Christians, to be sensible that they have all arisen from mean and absurd ideas of the moral attributes of God: for they have generally entertained noble opinions of his natural attributes. The Jews considered God as a partial Being, who had a predilection for their nation in preference to all others, and preferred external homage and ceremony to moral purity. If the Roman Catholics think consistently, they must esteem God as a Being who can be prevailed upon by the importunity of one dead man to assist another, or as a Being whose patience would be fatigued with hearing prayers constantly. Hence their practice of praying to saints. They in effect believe, however they may deceive themselves, that God is unjust, or they could not believe transubstantiation; for it supposes that God can give commands directly contrary to those principles of belief with which he has endued the human mind. They consider a strict adherence to a variety of ceremonies, to forms, to pomp, and show, as essential to the worship of God: this is treating God as a vainglorious Being. They thought it their duty to extirpate heretics: this was supposing God a cruel and revengeful Being. Even among Protestants, we are sorry to say, a great deal of superstition remains: we have not yet learned to consider God as a spirit, who is to be worshipped in spirit and in truth, as a pure moral benevolent Being; and hence arise all the superstitious practices which prevail among us.

Besides those superstitious opinions and practices which entirely respect our duty to God, there are others which may be termed *vulgar superstitions.* These also arise from imperfect and mean ideas of the moral attributes of God. To believe vulgar prophecies, which are always the effusions of madness or knavery, is to suppose that God, who has drawn a veil over futurity, and only delivers prophecies to accomplish some great moral purpose, sometimes gives them for no purpose at all, or to gratify idle curiosity, or to disclose such a knowledge of what is to happen as is inconsistent with the free agency of man and the moral administration of the world. Nor is it less superstitious to believe in vulgar miracles. To believe in them, is to believe that God suspends the laws of nature for the most trivial purposes, or to countenance fraud and worldly ambition: it is to receive the most extraordinary facts upon the most unsatisfactory evidence. The belief of witchcraft, of apparitions, and the second sight, may be resolved into the same principle. To suppose that God would communicate the power of doing mischief, and of controuling his laws, to any being merely for gratifying their own passions, is unworthy of God. The belief of apparitions is equally inconsistent with the goodness of God (see SPECTRE). The same

(A) We do not pretend to say that this is the sense in which superstition is always used, because it is often used improperly.

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same objection rises against the second-sight as against the belief of vulgar prophecies, and may also be extended to omens, to astrology, to things lucky and unlucky, to fortune-telling, &c. As to the different devices and charms for preventing and curing disorders, they resemble in every respect false miracles.

A judicious history of superstition would be a curious and entertaining work, and would exhibit the human character in a remarkable point of view. Superstition is most prevalent among men of weak and uncultivated minds; it is more frequent in the female sex than among men; and abounds more in the rude than in the refined stages of society. The general features of it have been the same in all ages; but it assumes certain peculiarities according to the diversity of character of different nations. It gained admission into the science of medicine at an early period. He who was endowed with superior genius and knowledge was reckoned a magician. Dr Bartolo was seized by the inquisition at Rome in the last century, because he unexpectedly cured a nobleman of the gout. Diseases were imputed to fascination, and hundreds of poor wretches were dragged to the stake for being accessary to them. Mercatus, physician to Philip II. of Spain, a writer of uncommon accuracy and information, appears strongly inclined to deny the existence of fascinatory diseases: but he is constrained to acknowledge them for two reasons; 1st, Because the inquisition had decided in favour of their reality; 2dly, Because he had seen a very beautiful woman break a steel-mirror to pieces, and blast some trees by a single glance of her eyes.

Manchester Transactions, vol. iii.

As the opinions concerning the cause of diseases were superstitious, those concerning the method of curing them were not less so. In the Odyssey we read of a cure performed by a song. Josephus relates, that he saw a certain Jew, named *Eleazar*, draw the devil out of an old woman's nostrils by the application of Solomon's seal to her nose in presence of the emperor Vespasian. Many different kinds of applications were used for expelling the devil. Flagellation sometimes succeeded admirably; purgatives and antispasmodics were other modes of discharging him. Dr Mynsight cured several bewitched persons with a plaster of assafœtida. How the assafœtida was so efficacious, was much disputed. Some thought the devil might consider so vile an application as an insult, and run off in a passion; but others very sagely observed, that as devils are supposed to have eyes and ears, it is probable they may have noses too.

Nor was it only in medicine these superstitious opinions were entertained; they prevailed also in natural philosophy. The pernicious effects in mines, which we now know are occasioned by noxious air, were confidently imputed to the demons of the mine. Even Van Helmont, Bodinus, Strozza, and Luther, attributed thunder and meteors to the devil. Chemists were employed for centuries in search of the philosopher's stone, with which they were to do miracles. It was a common question among philosophers in the 17th century, whether the imagination could move external objects; a question generally decided in the affirmative.

Though superstition be generally the mark of a weak mind, such is the infirmity of human nature, that we find many instances of it among men of the most sublime genius and most enlightened minds. Socrates believed that he was guided by a demon. Lord Bacon believed in witchcraft; and relates that he was cured of warts by rubbing them with a piece of lard with the skin on, and then nailing it with the fat towards the sun on the post of a chamber window facing the sun. Henry IV. one of the most illustrious of monarchs, was very uneasy before his assassination on account of some prophecies *. Sully declares, that one of the considerations that kept him faithful to his master in the most unpromising state of his affairs, was a prediction of La Brosse, that Henry would make his fortune †. The astrologer Morin directed Cardinal Richelieu's motions in some of his journeys ‡. The enlightened Cudworth defended prophecies in general, and called those who opposed the belief of witchcraft by the name of *atheists;* and the predictions of Rice Evans have been supported in the present century by the celebrated names of *Warburton* and *Jortin.* Dr Hoffman, the father of the Modern Theory and Practice of Medicine, in a dissertation published in the large edition of his works in 1747, says, that the devil can raise storms, produce insects, and act upon the animal spirits and imagination; and, in fine, that he is an *excellent optician and natural philosopher* on account of his long experience. Dr Johnson, the leviathan of literature, is supposed to have believed in the second sight.

* *Memoirs of Sully.*

† *Ibid.*

‡ *Bayle, art. Morin.*

With respect to the effects of superstition on the human mind, they are indeed deplorable. It chains down the understanding, and sinks it into the most abject and sordid state, and keeps it under the dominion of fear, and sometimes of cruelty. Where once it takes possession, it has a tendency to become extreme, and generally becomes so intolerable, that men of reflection and learning conspire its destruction. The Christian religion gave a violent shock to the heathen superstition; the reformation in a great measure demolished the superstition of the church of Rome; and the superstition which remained among Protestants after their separation from that church has been gradually yielding to the influence of enlightened reason, or to the bold and daring attacks of infidelity and deism. We behold the prospect of its ruins with pleasure, and thank the deists for their zeal; but it is from the firm hope that the religion of Jesus will arise in all its beauty and simple majesty, and be admired and respected as it deserves: for mean and contemptible as superstition certainly is, we would rather see men do what they reckon their duty from superstitious principles, than see anarchy and vice prevail, even though attended with all the knowledge and liberality of sentiment which deism and infidelity can inspire.

Superstition ‖ Supine.

SUPERVISOR, a surveyor or overseer.

SUPINATION, in *Anatomy*, the action of a supinator muscle, or the motion whereby it turns the hand so as that the palm is lifted up towards heaven.

SUPINE, in Latin grammar, part of the conjugation of a verb, being a verbal substantive of the singular number and the fourth declension.

There are two kinds of supines: one, called the *first supine*, ending in *um* of the accusative case, which is always of an active signification, and follows a verb of motion; as *abiit deambulatum.* The other called the *last supine*, and ending in *u* of the ablative case, is of a passive signification, and is governed by substantives or adjectives; as, *facile dictu*, &c.

They have their name, says Probus, and after him Vossius, Supine, Supper.

Vossius, *quod ad instar* supinorum *et otiosorum hominum omnia habent confusa*: or, according to Priscian, *quod nascantur a participiis passivis, quæ supina appellata sunt, quia in infimo loco sita, totam conjugationis molem suscipiant.*

SUPPER, the evening repast.—Suppers that are heavy should be avoided, because the stomach is more oppressed with the same quantity of food in a horizontal posture than in an erect one, and because digestion goes on more slowly when we sleep than when we are awake. They should be eaten long enough before bed-time, that they may be nearly digested before going to sleep; and then a draught of pure water will dilute that which remains in the stomach.

1 Definition.

Supper of the Lord, otherwise called the *Eucharist*, is a sacrament ordained by Christ in his church, of which the outward part is bread and wine, and the inward part or thing signified the body and blood of Christ, which the majority of Christians believe to be in some sense or other taken and received by the faithful communicants. See SACRAMENT.

2 Controversies about the outward and visible sign.

There is no ordinance of the gospel which has been the subject of more violent controversies between different churches, and even between different divines of the same church, than this sacrament; and though all confess that one purpose of its institution was to be a bond of love and union among Christians, it has, by the perverseness of mankind, been too often converted into an occasion of hatred. The outward and visible sign, and the inward and spiritual grace, have equally afforded matter of disputation to angry controvertists. Many members of the church of Rome condemn the Greek church and the Protestants for using leavened bread in the Lord's Supper, contrary to the example set them by our Saviour; whilst the Greek church in general, and some Protestant societies in particular, unite with the church of Rome in censuring all churches which mix not the wine with water, as deviating improperly from primitive practice. See EUCHARIST.

That it was unleavened bread which our Lord blessed and brake and gave to his disciples as his body, cannot be questioned; for at the time of the passover, when this ordinance was instituted, there was no leavened bread to be found in Jerusalem *. For the mixed cup, the evidence is not so decisive. It is indeed true, as we have observed under the article EUCHARIST, that the primitive Christians used wine diluted with water; and if we may believe Maimonides †, it was the general custom of the Jews, as well at the passover as at their ordinary meals, to add a little water to their wine on account of its great strength; but that this was *always* done, or that it was done by our *Saviour in particular*, there is no clear evidence. Origen indeed affirms ‡, that our Lord administered in wine unmixed; and he was not a man to hazard such an affirmation, had there been in his days any certain tradition, or so much as a general opinion, to the contrary. On this account we have often heard with wonder the necessity of the mixed cup insisted on by those who without hesitation make use of leavened bread; for if it be essential to the sacrament that the very same elements be employed by us that were employed by our Saviour, the necessit[y of] unleavened bread is certainly equal to that of wine [di]luted by water.

* *Exod.* xii. 15, 19.

† *In Mishnam.*

‡ *Hom.* 12. *in Hieremiam.*

But the mixed cup is said to be emblematical of [the] blood and water which flowed from the side of our L[ord] when pierced by the spear of the Roman soldier, wh[ilst] the absence of leaven is emblematical of no particu[lar] circumstance in His passion. This argument for [the] mixture is as old as the era of St Cyprian, and has si[nce] been frequently urged with triumph by those who sur[ely] perceived not its weakness. The flowing of the bl[ood] and water from our Saviour's side was the consequen[ce] either of the spear's having pierced the *pericardium*, [or] more probably of an *ascites* or *hydrothorax*, occasion[ed] by his cruel and lingering death (see MEDICINE, [N^o] 342, 343). But whatever was the cause of it, how c[an] the mixing of wine with water in the sacrament be e[m]blematical of the flowing of blood and water separatel[y]? such a mixture surely bears a more striking resemblan[ce] to the reunion of the *serum* and *crassamentum*, after th[ey] had been separated by whatever cause. See BLOOD.

We urge not these objections to the mixed cup fro[m] any dislike that we have to the practice. It is unque[s]tionably harmless and primitive; and we wish th[at] greater regard were paid to primitive practices than th[e] generality of Christians seem to think they can claim; but let the advocates for antiquity be consistent; le[t] them either restore, together with the mixed cup, th[e] use of unleavened bread, or acknowledge that neithe[r] the one nor the other is essential to the sacrament. Thi[s] last acknowledgement must indeed be made, if the[y] would not involve themselves in difficulties from whic[h] they cannot be extricated. If either the mixed cup o[r] unleavened bread be absolutely necessary to the validit[y] of the sacrament, why not wine made from the grape[s] of Judæa? why not that particular kind of wine which was used by our Saviour? and where is that wine to be found?

But the controversies respecting the outward part or sign of the Lord's Supper are of little importance when compared with those which have been agitated respecting the inward part or thing signified; and of these we hasten to give as comprehensive a view as the limits prescribed to such articles will admit.

Our Blessed Lord, in the same night that he was betrayed, "took bread, and blessed it, and brake it, and gave it to the disciples, and said, Take, eat; this is my body. And he took the cup, and gave thanks, and gave it to them, saying, Drink ye all of it; for this is my blood of the new testament, which is shed for many for the remission of sins." Such was the institution of the Lord's Supper as it is recorded in the gospel by St Matthew; and we have the same account of it, in almost the very same words, by three other inspired writers, St Paul, St Mark, and St Luke. That it was the bread which Christ blessed and brake that is here called his body, and the wine over which he gave thanks that he styles his blood of the new testament, will admit of no reasonable doubt (A); but in what sense they became so, has been the subject of many controversies.

The church of Rome, which holds, that after consecration, th[e] ... of

D

(A) Some over-zealous Protestants have indeed affirmed, that it was not the consecrated bread and wine, but those

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cration, Jesus Christ, God and man, is really, truly, and substantially, contained under the outward appearances of the bread and wine, informs us, that about the middle of the mass, when the priest, taking into his hand, first the bread and then the wine, pronounces over each separately the sacred words of consecration, the substance of these elements is immediately changed by the almighty power of God into the body and blood of Christ; but that all the outward appearances of the bread and wine, and all their sensible qualities remain. This more than miraculous change is called TRANSUBSTANTIATION; and is founded on the philosophy of Aristotle, which resolves all bodies into *matter* and *form* (see METAPHYSICS, N° 142—150.); for it is only the *matter* or imperceptible substance which supports the *forms* or sensible qualities of bread and wine, that is changed into the *substance* or matter of the body and blood of Christ, so that this divine matter, coming into the place of the former earthy matter, supports the same identical *forms* which it supported. Hence we are told, "that Jesus Christ, now present instead of the bread and wine, exhibits himself to us under those very same outward *forms* or appearances which the bread and wine had before the change."

Could this doctrine be true, it would be abundantly mysterious; but to add to the mystery, we are farther informed, that under each kind is contained Jesus Christ whole and entire, his body and blood, his soul and divinity; so that when a man eats what has the appearance of a wafer, he really and truly eats the body and blood, the soul and divinity, of Jesus Christ; and when he afterwards drinks what has the appearance of wine, he drinks the very same body and blood, soul and divinity, which not a minute perhaps before he had wholly and entirely eaten! The ingenious author from whose work we have taken this account of the Romish doctrine concerning the real presence, may perhaps reject our inference that the orthodox members of his church must believe the *soul* and *divinity* of Christ to be *eaten* and *drunk* in the Lord's supper; but he cannot deny that, according to his statement of the Catholic faith, the soul and divinity are both received whole and entire into the stomach of each communicant. He says indeed, that "communion consists in receiving Jesus Christ whole and entire, his sacred body, his precious blood, his blessed soul, and his adorable divinity, into our *souls*;" but that which was formerly bread and wine unquestionably goes into the *stomachs* of the communicants; and since, according to him, it is now the body and blood of Christ, the soul and divinity must go thither with it, for these four cannot be separated. This our author himself grants. "The Scripture (says he) positively declares, that *Christ rising again from the dead, dieth no more; death shall no more have dominion over him* (Rom. vi. 9.). Consequently his body, his blood, and his soul, shall never more be separated from one another; and as the union of his divine and human natures can never more be broken, so neither can these, his two natures, united in his divine person, be ever separated. From this it necessarily follows, that wherever the body of Christ is, there also his blood, his soul, and his divinity, must of necessity be in like manner."

Now, whether we suppose, with our author, that the soul and divinity of Christ directly carry his body and blood with them into the human soul, or, trusting, in some degree to the evidence of sense, believe that the body and blood carry his soul and divinity with them directly into the stomach of each communicant—is it credible, is it possible, that the high and lofty One, who inhabiteth eternity, and whom the oracles of truth assure us that even the heaven of heavens cannot contain, should be *substantially* received *whole* and *entire* into a finite spirit like the human soul, or into a body so limited as the human stomach? Our author says it is; declaring that, "by the blessed *presence* of Jesus Christ, *whole and entire within us*, are communicated to our souls all the heavenly graces which are the effects of the holy communion: such as the sanctification of the soul by an increase of justifying grace; the rendering of it more pure, more holy, more beautiful, more agreeable, in the eyes of God; the cleansing of the soul from all those venial sins and imperfections of which we repent, and preserving us from falling into mortal sins; the uniting of us in a most intimate manner with Jesus Christ, who comes to us in this holy sacrament on purpose to dwell in our souls and abide with us; and the giving us a pledge and earnest of a glorious immortality, to the enjoyment of which it brings us at last, if we persevere to the end in the grace of God."

The consequence of the doctrine of transubstantiation is the *sacrifice of the mass*, by which, it is said, God's acceptance of Christ's sacrifice on the cross is obtained for the actual benefit of those persons in particular for whom the mass is offered. In the work so often quoted, we are told, that "Jesus Christ our redeemer, who is both our high-priest and our victim, who, in order to perfect the work of our redemption, and reconcile man with his offended Creator, offered himself once in a bloody

those elements, *together with the whole action* of taking them into his hands, blessing them, breaking the bread, and distributing the bread and wine to the disciples, that Christ calls his body and blood. This novel and singular opinion rests upon no better foundation than a very childish criticism. Our Saviour, after blessing and breaking the bread, gave it to the disciples, saying, in the original, Λαβετε φαγετε ΤΟΥΤΟ εϛι το σωμα μου. Now, say our critics, τουτο, in the neuter gender, can never agree with the antecedent αρτος in the masculine, but must refer to all the circumstances of the action taken together, and considered as one complex neuter noun. But this noun, whether complex or simple, certainly denotes what could be *eaten;* and to suppose that our blessed Lord desired his apostles to eat *actions*, is as repugnant to human reason as any doctrine of the church of Rome. The truth is, that the word τουτο, which is more properly a definite article than a demonstrative pronoun (see GRAMMAR, Chap. II.), refers directly to the thing, whatever it was, which our Saviour held in his hand and gave to the disciples; and the clause when completed, is τουτο ον εϛι το σωμα μου; this *being*, this *substance*, *is my body*. There was no necessity for characterising that substance by any analogy to sex, in order that it might be distinguished from every other substance; for the apostles could not but see it in the hand of their Master.

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bloody manner upon the cross, in order to communicate and apply to the souls of individuals those graces, which, by his death, he merited for mankind in general, continues to offer himself daily upon the altar in an unbloody manner, by the ministry of his priests, in the *mass*. The sacrifice of the cross and that of the mass are both one and the same sacrifice, because in both the victim is the same and the high priest the same, viz. Jesus Christ. The only difference is in the *manner* of offering. On the cross he offered himself in a bloody manner, and actually died; whereas on the altar he is offered up to God in an unbloody manner, not *actually* dead, but under the *appearance* of death;" so that the communicants not only eat the man Jesus Christ, but even eat him alive (B)!

It is known to all our readers that this doctrine of transubstantiation was one cause of the breach between the church of Rome and those various societies which call themselves reformed churches. The real and substantial change of the bread and wine into the body and blood of our Lord is rejected by every reformer as a change contradictory and impossible, and fraught with the most impious consequences; and volumes have been written to expose the weakness of those arguments which have so often been vainly urged in its support. It has been shown to imply numberless absurdities, such as, that the same thing can be in a million of different places, *whole* and *entire*, at the same instant of time; that it is above 1800 years old, and yet may be not more than one minute; that *forms* or sensible qualities are real things independent of their subject and the sentient beings who perceive them; that the infinite and eternal God, who created and sustains the universe, is himself wholly and substantially comprehended by the human soul; and that the half, or fourth, or tenth part of the body of Christ, is equal to the whole of that body. That these are necessary consequences of transubstantiation has been so completely proved in various works (C) to which every reader may have access, that it is needless for us to repeat arguments so hackneyed; but there are two objections to that doctrine, which, as we do not remember to have met with them elsewhere, and as they appear to us absolutely conclusive, it may be worth while to state in this place.

6
Implies numberless contradictions.

The advocates for the real presence in the Lord's Supper contend, that every word relating to that ordinance is to be taken in the strictest and most literal sense, and they affect to triumph over the Protestants, because their notions of the sacrament cannot be supported without having recourse to figure and metaphor. This however is a very vain triumph; for we hesitate not to affirm, that supposing transubstantiation possible, and even capable of proof, there is not in the whole New Testament a single word or a single phrase which, if interpreted *literally*, gives the slightest countenance to that wonderful doctrine. The reader will remember, that transubstantiation, as we have stated it from a dignitary of the Romish church, and as it is in fact stated by the council of Trent (D), consists in a change of the *matter*, *imperceptible substance*, or *substratum* of the bread and wine, into the *matter*, *imperceptible substance*, or *substratum* of Christ's body and blood; for all parties agree that the sensible qualities of the bread and wine remain, and, according to the Romanist, are after consecration either supported by the *matter* of Christ's body and blood, or hung upon nothing. But the phrase τουτο ἐςι το σωμα μου,

7
is contrary to Scripture,

(B) This whole account of the Romish doctrine respecting the sacrament of the Lord's Supper is taken from a work in two small volumes, called *The Sincere Christian instructed in the Faith of Christ, from the Written Word*. Its author is a man of learning, and great personal worth: and as he fills a high station in the church of Rome, we cannot doubt but that he has given a fair view of the doctrine of that church respecting this and every other article of which he treats. We are sorry however that his zeal should have impelled him, in a *popular* work, to write in the manner that he has done of the salvation of those who are not members of his church, or who cannot embrace all his opinions; for if his doctrine on this subject be implicitly received by those "over whom he has the rule, and for whose souls he is appointed to watch," they must necessarily look upon the majority of their fellow-citizens as reprobates doomed to eternal perdition. Let this be our apology for treating some of those opinions, which he thinks so absolutely necessary to salvation, with less ceremony than perhaps we should have done, had he less positively pronounced our damnation for not having it in our power to embrace them. He is not indeed much less severe on the most virtuous heathens, though they never saw the New Testament, or heard the doctrines of his church preached. But perhaps this severity may be occasioned by the following question of Cicero: "Cum fruges, *Cererem*; vinum, *Liberum* dicimus, genere nos quidem sermonis utimur usitato: sed ECQUEM TAM AMENTEM esse putas, qui illud, quo vescatur, deum credat esse?"—*De Natura Deorum*, lib. iii. cap. 16.

(C) Among other works on this subject, we may confidently recommend to the reader a small tract published by Dr Abernethy Drummond, about thirty years ago, in the form of *A Dialogue between Philalethes and Benevolus*. In that treatise, together with a defence of it, which were both printed for Balfour and Drummond, Edinburgh, the absurd consequences which we have mentioned are, by arguments unanswerable, proved to flow from the doctrine of transubstantiation; and the artful sophistry, by which a very acute genius endeavoured to keep these consequences out of sight, is detected and exposed on acknowledged principles of the soundest metaphysics.

(D) The canon of that council which establishes transubstantiation is thus translated by the author of *The Sincere Christian Instructed*: "If any man shall say, that in the blessed sacrament of the Eucharist the substance of the bread and wine remains along with the body and blood of our Lord Jesus Christ, and shall deny that wonderful and singular conversion of the whole substance of the bread into the body, and of the whole substance of the wine into the blood, the appearances of the bread and wine only remaining, which conversion the Catholic Church calls *transubstantiation*, let him be anathema."

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μου, if taken in the literal sense, cannot possibly denote the consequence of such a change as this; for every person at all acquainted with the Greek language, especially the language of the Peripatetic school, knows that το σωμα μου signifies, not the *matter* or *substratum* of my body divested of its sensible qualities; but the body of me in its natural state, consisting of *matter* and *qualities*, or *matter* and *form united.* Unless therefore the *sensible qualities*, as well as the *matter* of the bread and wine, give place to the sensible *qualities* as well as the *matter* of our Saviour's body and blood, and unless he appear glorified on the altar as he appeared on the mount at his transfiguration, the words το σωμα μου must be interpreted figuratively. Had the apostles understood their Master's words in the sense in which they are understood by the church of Rome, they would have rendered them into Greek, not τουτο εστι το σωμα μου, "this is my *body*," but τουτο εστι η ὑλη του σωματος μου, "this is the *matter* of my body." In like manner, when St John relates * that Jesus said, "Whoso eateth my flesh and drinketh my blood, hath eternal life, and I will raise him up at the last day," had he understood his adorable Master to speak of his flesh and blood in the Eucharist in the sense in which they are taught to be there by the church of Rome, he would have represented him as saying, not Ὁ τρωγων μου την σαρκα, και πινων μου το αἱμα, but Ὁ τρωγων την ὑλην μου της σαρκος, και πινων την ὑλην μου του αἱματος, "whoso eateth the *matter* of my flesh, and drinketh the *matter* of my blood, hath eternal life, and I will raise him up at the last day."

* Chap. vi. verse 54.

8 and incapable of proof.

But further, supposing this singular conversion possible in itself, it cannot be rendered credible, however stated in any language that ever was or ever will be spoken by man. At first sight it may appear paradoxical to affirm, that a possible fact cannot be so related as to obtain credit; but that transubstantiation, if possible, is such a fact, will be apparent on the slightest consideration.

The relation which subsists between things and words is arbitrary; so that what is termed *body* in English, is σωμα in Greek, and *corpus* in Latin; and the same thing might with equal propriety (had the authors of these languages so pleased) have been expressed in the first by *soul*, in the second by νους, and in the third by *anima.* (See LANGUAGE, N° 3, &c.). The consequences of this are, that there is no universal language spoken; that the natives of one country understand not the speech of those of another; and that different men speaking the same language are perpetually liable to mistake each other's meaning. Between the *substrata* of bodies and their *sensible qualities* there is a relation founded in nature, so that the sensible qualities which indicate the substance to which they belong, to be *gold*, for instance, in one country, indicate the same thing in every other country, and have done so from the beginning of time. The sensible appearances of bodies therefore are an universal language, the language of the Author of Nature, by which he declares to his creature man, that though the ὑλη πρωτη, or primary matter of all bodies, may be the same kind of substance; yet the ὑλη προσεχης of one body, or the internal combination of its primary parts, differs from that of another; that gold, for instance, has a different *substratum* or *basis* from iron, lead, or silver; that the internal organization or structure of the body of an ox is different from that of a horse; and that the *internal substance* or *substratum* which exhibits the appearances of bread and wine is different from that which supports the sensible qualities of flesh and blood (see METAPHYSICS, Part I. Chap. I. and Part II. Chap. I. and II.). Supposing therefore the doctrine of transubstantiation to be possible and even true, it would still be impossible, by any statement in human language, or by any argument urged in its support, to render that doctrine an object of rational belief; for if it be said that the words τουτο εστι το σωμα μου were spoken by a divine person, who could neither be deceived himself nor intend to deceive us, it may be replied, that the sensible appearances of bread and wine, which are confessed to remain, are likewise the language of a divine person, even of the Creator and Governor of heaven and earth; that this language addressed to the sight, the taste, the touch, and the smell, is equally intelligible to all nations; that since the creation of the world its meaning has never been mistaken by the scholar or the clown, the sage or the savage, except in this single instance of our Lord's flesh and blood exhibiting the sensible appearances of bread and wine; and that it is therefore infinitely more probable that the members of the church of Rome should mistake the meaning of the words τουτο εστι το σωμα μου, which, though spoken by Christ, are part of the language of men, and liable to all its ambiguities, than that all mankind should mistake the language of God himself, which is liable to no ambiguities, and which was never in any other instance misunderstood by a single individual. Should transubstantiation therefore be really true, its truth can never be proved or rendered probable, but by an immediate operation of the spirit of God on the mind of man; and he who is conscious of no such operation on his own mind, may rest assured that the Father of mercies, who knows whereof he is made, will never bring upon him, for his incredulity in this instance, any of the anathemas denounced by the church of Rome upon those who place implicit confidence in the universal language of Him who created them, in opposition to her figurative and contradictory interpretations of the written word. Of the transubstantiation of the elements a visible miracle would afford no proof. Had the water been changed into wine at the marriage in Cana of Galilee, for the express purpose of bearing testimony to this singular conversion, what must have been the consequence on the minds of those who witnessed that miracle? Nothing, we think, but scepticism or distrust of their own faculties; for they would have had the very same evidence that *no* substantial change was wrought on the elements, as that the water was *actually* turned into wine.

Though the reformed churches unanimously reject the doctrine of transubstantiation, and of course the sacrifice of the mass, its inseparable consequence, they are far from being agreed among themselves respecting the nature of the Lord's Supper; and the notions of this ordinance entertained by some of them appear to us as untenable as any part of the doctrine of the church of Rome. The Lutherans believe, that the body and blood of Christ are really and substantially present with the bread and wine; that the body is really and truly eaten, and the blood really and truly drunk, by the communicants; and that whatever motion or action the bread has, the body has the same *. According to them, therefore,

9 Doctrine of the Lutherans incredible.

* *Luther. Cogit. MS.* 40. *Gerhard in Loc. Theol. de Sacra Cæna.*

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therefore, the same sensible appearances are exhibited by two substances united in some inexplicable manner, which is neither a personal union, nor incorporation, nor the inclosure of the body within the bread; nor does it last longer than while the sacrament is celebrating. This union is generally called CONSUBSTANTIATION; but they reject the term, contenting themselves with asserting the real presence, without presuming to define the mode by which the body and blood of Christ are united to the sacramental elements.

It would be superfluous to waste time in replying to this doctrine. Every reader sees that it implies the possibility of the same thing's being whole and entire in a million of places at one and the same instant of time, which has been so often urged as an unanswerable objection to the Romish doctrine; and it is fraught with this additional absurdity peculiar to itself, that two bodily substances may at once occupy the same place, which is directly contrary to our notions of solidity. It may be observed too, that whatever be the real sense of our Saviour's words, he says expressly, "This is my body"—this thing which I give you, and which you see and feel; whereas, had he meant what Luther and his followers teach, he would surely have said, "*With* this bread receive my body, *with* this cup receive my blood."

10 Of the early Calvinists,

The notions of some of the early Calvinists respecting the Lord's Supper are very mysterious, and expressed in language of which we are not sure that we understand the meaning. In the year 1561 an attempt was made in France to bring the Catholics and Protestants to an uniformity of doctrine on this great topic of controversy; and deputies were appointed by both parties to meet at *Poissy*, and debate the question in a friendly manner. The principal managers on the side of the Catholics were the cardinals of *Lorraine* and *Tournon*; those on the side of the Protestants were *Beza* and *Peter Martyr*. After several meetings, disputes, and violent separations, the Protestant deputies declared their faith in the following words: "We confess, that Jesus Christ, in the Supper, does truly give and exhibit to us the substance of his body and blood by the efficacy of his Holy Spirit; and that we do receive and eat spiritually, and by faith, *that very body which was offered and immolated for us*, so as to be bone of his bone and flesh of his flesh, to the end that we may be enlivened thereby, and receive what is conducive to our salvation. And because faith, supported by the word of God, makes those things present, which it apprehends, and by that faith we do in *deed* and *reality* receive the *true natural* body and blood of Christ, by the power of the Holy Spirit; by this means, we confess and acknowledge the presence of his body and blood in the Supper." One of the Catholic delegates expressing his dislike of this last clause, the Protestant ministers gave the following explanation of their sentiments: "No distance of place can hinder us from communicating of the body and blood of Christ, for the Lord's Supper is a heavenly thing; and though on earth we receive with our mouths bread and wine, which are the true signs of his body and blood, yet by faith, and the efficacy of the Holy Ghost, our minds, which are fed with this food, *are rapt up into heaven*, and enjoy the presence of the body and blood; and that by this means it may be said that the body is truly joined to the bread, and the blood to the wine; but after the manner of a sacrament, and not at all according to plac[e] or natural position *."

If the reader can discover the precise meaning o[f] these passages, his sagacity exceeds ours. That th[e] Protestant deputies believed, or professed to believe that the *natural* body and blood of Christ are by th[e] faithful received in the Lord's Supper, is indeed evi[dent]; but their notions respecting the manner of this reception are very unintelligible, if not contradictory. In the former quotation, they confess that Christ's body and blood are really present in the sacrament; that they are made present by faith (we suppose the faith of the communicants); and that the *very body* which was offered and immolated for us is eaten *spiritually* and by *faith*. In the latter quotation, they seem to say that Christ's body and blood are in heaven, at a great distance from the true signs of them; that on earth the communicants receive only these signs, which are bread and wine; but that, by faith and the efficacy of the Holy Spirit, their minds, during actual communion, are rapt up into heaven, where they enjoy the presence of the body and blood; and that by this means the body and blood are truly joined to the bread and wine through the medium of the mind of the communicant, which is at once present both to the sign and to the thing signified. To this mysterious doctrine it is needless to urge objections. Every man who is accustomed to think, and to use words with some determinate meaning, will at once perceive that the authors of this declaration must have had very confused notions of the subject, and have pleased themselves with sound instead of sense, satisfied that they could not be wrong if they did not symbolize with the Lutherans or the Council of Trent.

Of [the] chu[rches of] Bri[tain].

The churches of England and Scotland, in their established doctrines respecting the Lord's Supper, appear to be Calvinistical; but the compilers of the Thirty-nine Articles and of the Confession of Faith must have been much more rational divines than Beza and Peter Martyr. They agree in condemning the doctrine of transubstantiation as contrary to common sense, and not founded in the word of God; they teach, that to such as rightly, worthily, and with faith, receive the sacrament, the bread which we break is a partaking of the body of Christ, and the cup of blessing a partaking of the blood of Christ; and they add, that the body and blood of Christ are eaten and drunk, not corporally or carnally, but only after a heavenly and spiritual manner, by which the communicants are made partakers of all the benefits of his death †. In one important circumstance these two churches seem to differ. The Confession of Faith, as we understand it ‡, affirms, that in the Lord's Supper there is no sacrifice made at all. The thirty-first article of the church of England likewise condemns the Popish sacrifice of the mass as a *blasphemous fable* and *dangerous deceit*; but in *the order for the administration of the Lord's Supper or Holy Communion*, the celebrator "beseeches God most mercifully to accept the alms and *oblations* of the congregation," and again "to accept *their sacrifice of praise* and thanksgiving:" from which petitions many have inferred that, in the Lord's Supper, that church offers a commemorative and eucharistical sacrifice. This inference seems not to be wholly without foundation. In the order for the administration of the Lord's Supper, according to the form of the Book of Common Prayer set forth by act of parliament

† *Ar[ticles] of th[e] Chur[ch of] Engl[and]*, art. 2[8]. *and C[onfes]sion o[f] Faith* chap[.]
‡ Chap[.] § 3.

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liament in the second and third years of King Edward the Sixth, the elements were solemnly offered to God as a sacrifice of praise and thanksgiving; and though the prayer containing that oblation was, at the review of the liturgy some years afterwards, removed from the prayer of consecration, to which it was originally joined, and placed where it now stands in the post communion service; yet the very act of parliament which authorized that alteration, calls King Edward's "a very godly order, agreeable to the word of God and the primitive church, and very comfortable to all good people desiring to live in Christian conversation."

13 Some English divines hold the Lord's Supper to be a eucharistical sacrifice.

The English church, however, has not positively determined any thing respecting this great question; and whilst she condemns the doctrine of the real presence; with all its dangerous consequences, she allows her members to entertain very different notions of this holy ordinance, and to publish these notions to the world. Accordingly, many of her most eminent divines (E) have maintained that, in the celebration of the Lord's Supper, the elements of bread and wine are offered to God as a sacrifice commemorative of Christ's one sacrifice for the sins of the whole world; that these elements, though they undergo no substantial change, yet receive such a divine virtue by the descent of the Holy Ghost, as to convey to the worthy communicant all the benefits of Christ's passion; that they are therefore called his body and blood, because being, after their oblation, eaten and drunk in remembrance of Him, they supply the place of his body and blood in the feast upon his sacrifice; and that it is customary with our Saviour to give to any thing the name of another of which it completely supplies the place, as when he calls himself the *door** of the sheep, because there is no entrance into the church or kingdom of God but by faith in him. They observe, that the Eucharist's being commemorative, no more hinders it from being a proper sacrifice, than the typical and figurative sacrifices of the old law hindered them from being proper sacrifices: for as to be a type doth not destroy the nature and notion of a legal sacrifice, so to be representative and commemorative, doth not destroy the nature of an evangelical sacrifice. To prove that, in the celebration of the Lord's Supper, there is a real sacrifice offered to God as well as a sacrament received by the communicants, they appeal to St Paul, who says expressly †, that "Christians have an *altar*, whereof they have no right to eat who serve the tabernacle," and who by contrasting the cup of the Lord with the cup of devils, and the table of the Lord with the table of devils ‡, teaches plainly, that those cups and those tables had the same specific nature. That the *table of devils* spoken of by the apostle was the Pagan altars, and the *cup of devils* the wine poured out in libations to the Pagan divinities, will admit of no dispute; and therefore, say the advocates for the eucharistical sacrifice, the table of the Lord must be the Christian altar, and the cup of the Lord the wine offered to God as the representative of the blood of Christ; otherwise there would not be that *absurdity* which the apostle supposes, in the same person drinking the cup of the Lord and the cup of devils, and partaking of the Lord's table and the table of devils. They observe farther, that in all the ancient liturgies extant there is a solemn form of oblation of the sacramental elements, and that all the Christian writers from the second century downwards treat of the Lord's Supper as a sacrifice as well as sacrificial feast, having indeed no value in itself, but acceptable to God as representing Christ's one sacrifice for the sins of the world. Our limits will not permit us to give even an abstract of their arguments; but the reader who shall attentively peruse *Johnson's unbloody Sacrifice and Altar unveiled and supported*, will discover that their notions are better founded than probably he supposes, and that they are totally irreconcileable with the doctrine of transubstantiation and the Popish sacrifice of the *mass*.

* St John x. 7.

† Heb. xiii. 10.

‡ 1 Cor. x. 16, &c.

14 Others, a mere memorial;

Other English divines of great learning, with the celebrated Hoadley bishop of Winchester at the head of them, contend strenuously that the Lord's Supper, so far from being a sacrifice of any kind, is nothing more than bread and wine reverently eaten and drunk, in remembrance that Christ's body was broken and his blood shed in proof of his Father's and his own love to mankind; that nothing is essential to the sacrament but this remembrance, and a serious desire to honour and obey our Saviour as our head; that the sacrament might be celebrated without uttering one prayer or thanksgiving, merely by a society of Christians, whether small or great, jointly eating bread and drinking wine with a serious remembrance of Christ's death; that St Paul enjoins a man to examine himself before he eat of that bread and drink of that cup, not to discover what have been the sins of his past life in order to repent of them, but only that he may be sure of his remembering Christ's body broken and his blood shed; that, however, it is his duty in that as in every other instance of religious worship to resolve to obey from the heart every precept of the gospel, whether moral or positive; and that to partake worthily of the Lord's Supper is acceptable to God, because it is paying obedience to one of these precepts; but that no particular benefits or privileges are annexed to it more than to any other instance of duty. Bishop Hoadley acknowledges, that when St Paul says *, "The cup of blessing which we bless, is it not the communion of the blood of Christ? The bread which we break, is it not the communion of the body of Christ?" he has been supposed by many learned men to affirm, that all the benefits of Christ's passion are in the Lord's Supper conveyed to the worthy communicant; but this (says he) is an idea which the apostle could not have in his thoughts as at all proper for his argument. The Greek word *κοινωνια* and the English *communion* signify only a partaking of something in common with others of the same society; and the apostle's meaning (he says) can be nothing more, than that in the Lord's Supper we do not eat bread and drink wine as at an ordinary meal, but as memorials of the body and blood of Christ, in honour to *him* as the *head* of that body of which we are all *members*. That the word *κοινωνια* is not meant to denote any inward or spiritual part of the Lord's Supper, he thinks evident, because the same word is used with regard to the cup and the table of idols, where no spiritual

* 1 Cor. x. 16.

(E) The archbishops Laud and Wake; the bishops Poynet, Andrews, Bull, and Patrick; the doctors Hickes, Grabe, and Brett; Messrs Bingham, Johnson, Mede, Wheatly, Scandaret, Bowyer, &c.

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spiritual part could be thought of, and in an argument which supposes an idol to be nothing†.

† *A Plain Account of the Nature and End of the Lord's Supper.*

To this view of the nature and end of the Lord's Supper, it must appear no small objection, that "he who eateth and drinketh unworthily is said to be *guilty of the body and blood of the Lord, and to eat and drink a judgment to himself, not discerning the Lord's body.*" No doubt it would be sinful to eat and drink a mere memorial of Christ's death without serious dispositions; but we cannot conceive how a little wandering of the thoughts, which is all the unworthiness which the author thinks there can be on such an occasion, should be a sin of so deep a dye as to be properly compared with the guilt of those who murdered the Lord of life. Other divines, therefore, feeling the force of this and similar objections, steer a middle course between the mere memorialist and the advocate for a real sacrifice in the holy

15 and others, a feast upon our Saviour's sacrifice.

Eucharist, and insist that this rite, though no sacrifice itself, is yet a feast upon the one sacrifice offered by Christ and slain upon the cross. The most eminent patrons of this opinion have been Dr Cudworth, Bishop Warburton, and the present bishop of Chester; and they support it by such arguments as the following: "In those ages of the world when victims made so great a part of the religion both of Jews and Gentiles, the sacrifice was always followed by a religious feasting on the thing offered; which was called the *feast upon or after the sacrifice*, and was supposed to convey to the partakers of it the benefits of the sacrifice. Now Jesus (say they), about to offer himself a sacrifice on the cross for our redemption, did, in conformity to general practice, institute the *last supper*, under the idea of *a feast after the sacrifice:* and the circumstances attending its institution were such, they think, that the apostles could not possibly mistake his meaning. It was just before his passion, and while he was eating the paschal supper, which was a Jewish *feast upon the sacrifice*, that our blessed Lord instituted this rite; and as it was his general custom to allude, in his actions and expressions, to what passed before his eyes, or presented itself to his observation, who can doubt, when, in the very form of celebration, we see all the marks of a *sacrificial supper*, but that the divine institutor intended it should bear the same relation to his *sacrifice on the cross* which the *paschal supper* then celebrating bore to the oblation of the *paschal lamb?* If this was not his purpose, and if nothing more was intended than a general memorial of a dead benefactor, why was this instant of time preferred for the institution to all others throughout the course of his ministry, any one of which would have been equally commodious? Indeed any other time would have been more commodious for the institution of a mere memorial; for the paschal lamb and unleavened bread were certainly a sacrifice; and the words used by our Saviour, when he gave the bread and wine to the apostles, were such as must necessarily have led them to consider that bread and wine as bearing the same relation to his sacrifice that the paschal supper bore to the paschal sacrifice. At that Jewish feast, it was the custom of every father of a family to break the unleavened bread, and to give to every guest a portion, saying, "This is the bread of affliction, which our fathers did eat in the land of Egypt:" a custom which, we may be sure, that Christ, as father of his family, would religiously observe. The apostles knew well that they were not eating the identical bread which their fathers did eat in Egypt, but the feast upon the sacrifice then offered in commemoration of their redemption from Egyptian bondage; and therefore when they saw their Master after supper break the bread again and give it to each of them, with these remarkable words, "This is my body which is given for you, do this in remembrance of me," they must have concluded, that his meaning was to institute a rite which should to the end of the world bear the same relation to his sacrifice that the paschal supper bore to the sacrifice of the passover.

This inference, from the circumstances attending the institution, Bishop Warburton thinks confirmed by St Paul's mode of arguing with the Corinthians, on their impiety and absurdity in partaking both of the Lord's table and the table of devils; for "what (says he) had the eaters of the sacrifices to do with the partakers of the bread and wine in the Lord's Supper, if the Lord's Supper was not a feast of the same kind with their feasts? If the three feasts, Jewish, Pagan, and Christian, had not one common nature, how could the apostle have inferred that this intercommunity was inconsistent? *Ye* CANNOT (says he) *drink the cup of the Lord and the cup of devils; ye* CANNOT *be partakers of the Lord's table and the table of devils.* For though there might be *impiety* in the promiscuous use of Pagan and Christian rites of any kind, yet the *inconsistency* arises from their having a common nature, and consequently, as they had opposite originals, from their destroying one another's effects in the very celebration. Sacrifices, and feasts upon sacrifices, were universally considered as *federal* rites; and therefore the Lord's table and the table of devils being both *federal* rites, the same man could no more be partaker of both, than he could at once engage to serve both God and the devil. This is the apostle's argument to the wise men, to whom he appeals; and we see that it turns altogether upon this postulatum, that the Christian and Pagan feasts had the same specific nature, or were both feasts upon sacrifices. If this be admitted, it is easy to see why St Paul deemed those who ate and drank unworthily guilty of the body and blood of the Lord; for if the Lord's Supper be a feast upon his sacrifice, it must have been considered as the means of conveying to the communicants all the benefits of his death and passion; and the profanation of such a rite, by rendering his death ineffectual, might be fitly compared and justly equalled to the enormous guilt of those by whom his blood was shed." In reply to Bishop Hoadley's remarks upon the word *κοινωνια*, his brother bishop observes, that "had the apostle meant what the learned writer makes him to mean, he would doubtless have said *κοινωνια ὑμων εις το σωμα*, 'your communion in the body—your eating it jointly.' St Paul (continues he) knew how to express himself properly, as appears from a passage in his epistle to the Philippians, where, professedly speaking of the joint participation of a blessing, he uses these words, *κοινωνια ὑμων εις το ευαγγελιον*, 'your communion in the gospel.' To the other remark, that no spiritual part could be thought of in the table of idols, because an idol is said by the apostle to be *nothing*, Bishop Warburton replies, "that by St Paul the Gentiles are said to have sacrificed to devils, and those who ate of such sacrifices to have had communion with devils: now the *devil* (continues his Lordship) was in St Paul's opinion *something*." But the inference which

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the apostle draws from the acknowledged truth, that the cup of blessing which we bless is the communion of the blood of Christ, and the bread which we break the communion of the body of Christ, puts his meaning, our author thinks, beyond all doubt. He says *, that the partaking of one bread makes the receivers of *many* to become *one body*. A just inference, if this rite be of the nature of a *feast upon the sacrifice*; for then *the communion of the body and blood of Christ* unites the receivers into one body by an equal distribution of one common benefit. But if it be only a general commemoration of a deceased benefactor, it leaves the receivers as it found them, not *one body*, but *many separate professors* of one common faith.

* 1 Cor. x. 27.

16 The ordinance not generally understood.

Thus have we given such a view as our limits would permit us to give, of the principal opinions that have been held respecting the nature and end of the Lord's Supper. It is an ordinance which seems not to be generally understood; though, being intended to show forth the Lord's death till he come, it is surely of sufficient importance to engage the attention of every serious Christian. The most considerable Protestant divines who have expressly written upon it are, Johnson in his *Unbloody Sacrifice;* Cudworth in his *Discourse concerning the true Nature of the Lord's Supper;* Hoadley in his *Plain Account;* and Warburton in his *Rational Account*. The notions of Cudworth and Warburton are the same, and perhaps they differ not so much from those of Johnson as many readers seem to imagine. At any rate, the arguments by which Warburton supports his doctrine must have some force, since it is said that Hoadley himself acknowledged they would be unanswerable, if it could be proved that the death of Christ was a real sacrifice.

SUPPLEMENT, in literature, an appendage to supply what is wanting in a book. Books of various kinds require such an appendage; but none so much as a dictionary of arts and sciences, which, from the progressive course of physical science, cannot be completed without it.

SUPPORTED, in *Heraldry*, a term applied to the uppermost quarters of a shield when divided into several quarters, these seeming as it were supported or sustained by those below. The chief is said to be supported when it is of two colours, and the upper colour takes up two-thirds of it. In this case it is supported by the colour underneath.

SUPPORTERS, in *Heraldry*, figures in an achievement placed by the side of the shield, and seeming to support or hold up the same. Supporters are chiefly figures of beasts: figures of human creatures for the like purpose are called *tenants*.

SUPPOSITION, in *Music*, is when one of the parts dwells on a note, while another part makes two or more lesser notes equivalent to it, by conjoint degrees.

Supposition is defined by a late author the using of two successive notes, of the same value as to time; the one whereof, being a discord, supposes the other a concord.

The harmony, Mr Malcolm observes, is always to be full on the accented parts of the bar or measure; but, on the unaccented, discords may transiently pass, without any offence to the ear. This transient use of discords followed by concords, make what we, after the French, call *supposition*.

Concords by supposition are those where the continued bass adds or supposes a new sound below the fundamental bass; whence such concords always succeed the extent of the octave. Of these concords there are three sorts, all which are concords of the seventh: the first, when the added sound is a third below the fundamental sound; such is the concord of the ninth: and if the concord of the ninth is formed by the mediant, added below the sensible concord in the minor mode, then the concord is called the *superfluous fifth*. The second kind is, when the supposed sound is a fifth below the fundamental sound, as in the concord of the fourth or eleventh; and if the concord is sensible, and the tonic be supposed, this concord is called the *superfluous seventh*. The third kind is that where the supposed sound is below a concord of the diminished seventh; if it is a fifth below, i. e. if the supposed sound be the mediant, the concord is called the concord of the *fourth* and *superfluous fifth*: if it is a seventh below, i. e. if the supposed sound be the tonic, the concord is called the *lesser sixth* and *superfluous seventh*.

SUPPOSITORY, a kind of medicated cone or ball, which is introduced into the anus for opening the belly.

It is usually composed of common honey, mixed up with soap or oil, and formed into pieces of the length and thickness of the little finger, only pyramidal. To the composition is sometimes also added powder of scammony, euphorbium, colocynthis, salt, aloes, &c. according to the case of the patient.

The suppository was invented for the convenience of such as have an aversion to clysters; or to be used when the disease does not allow their use.

SUPPRESSION, in *Medicine*, is generally used to signify a retention of urine or of the menses.

SUPPURATION, the second way wherein an inflammation terminates; being a conversion of the inspissated blood and the first adjacent parts, as the vessels and fat, into pus or matter; which disorder, when it has not yet found an opening, is generally called an *abscess*.

SUPRACOSTALES, in *Anatomy*. See *Table of the Muscles* in ANATOMY.

SUPRALAPSARIANS, in *Theology*, persons who hold that God, without any regard to the good or evil works of men, has resolved, by an eternal decree, *supra lapsum*, antecedently to any knowledge of the fall of Adam, and independently of it, to save some and to damn others; or, in other words, that God intended to glorify his justice in the condemnation of some, as well as his mercy in the salvation of others; and for that purpose decreed that Adam should necessarily fall, and by that fall bring himself and all his offspring into a state of everlasting condemnation.

These are also called *antelapsaries*, and are opposed to sublapsaries and infralapsaries.

According to the supralapsarians, the object of predestination is, *homo creabilis et labilis;* and, according to the sublapsarians and infralapsarians, *homo creatus et lapsus*.

SUPRASPINATUS, in *Anatomy*. See *Table of the Muscles* in ANATOMY.

SUPREMACY, the superiority or sovereignty of the king. See SOVEREIGNTY.

SUR, or SHUR, in *Ancient Geography*, a desert of Arabia Petræa, extending between Palestine and the Arabian

Sur, Surat.

Arabian gulf; into which the Israelites, after marching through the Red sea, first came (Exod. xv. 22.). Again (Numb. xxxiii. 8.), it is said, that from the sea they went three days journey into the Wilderness of Etham; whence some conclude that Etham and Shur are the same wilderness; or only differ as a part from the whole, Shur being the general name, and Etham that part of it lying nearest to the place of encampment of the same name. We know so little of the geography of these places, that there is more room for disputation than for decision. As to the route which the Israelites followed in their passage through the Red sea, Mr Bryant, we think, has given the most satisfactory account in his late work on the Plagues of Egypt.—Shur is now called *Corondel*.

SURAT, a city of Indostan, belonging to Britain, on the western coast of the peninsula, a little to the northward of Bombay, and about 16 miles up the river Tappee. It is but of modern date, and is a most remarkable instance of the power of trade to bring wealth and population to any spot where it can be brought to settle. Towards the middle of the 17th century, this place was only the resort of a few merchants, who, under the shelter of an old insignificant castle, laid the first foundations of a city now almost as large as London, with many fine buildings of Indian architecture, partly Gentoo and partly Morisque, and supposed to contain nearly 600,000 souls. The buildings of the greatest note are so contrived, that the gateway is defensible against any sudden irruption of a few armed men. The private apartments lie backwards for the conveniency of the women, of whom the Moors are remarkably jealous. They are fond of having one room, in the midst of which a fountain keeps playing, and which, by its noise, lulls them to sleep, and refreshes the room by its coolness; but thus a damp is produced, which would be very dangerous to Europeans. They have also generally a saloon with fountains playing in it, which, with the variegated flower-beds, in which they are very curious, makes a beautiful prospect. During the intense heats of summer they have country retirements a little way out of town, where they reside, or go in parties to amuse themselves. The streets are irregularly laid out; but have one property which renders it agreeable to walk in them, viz. that a competent width being left at bottom, the upper stories of the houses project over one another in such a manner, that people may with ease converse from them; by which means the street is agreeably shaded, at the same time that a proper ventilation is not impeded, but rather promoted. The shops, notwithstanding the vast trade carried on in this great and populous city, have a very mean appearance, owing to the dealers keeping their goods in warehouses, and selling by samples.

No place is better supplied with provisions than the city of Surat while its communication with the country remains open. Besides the unbounded importation, by which every article is brought here in great abundance, the natural productions of the soil are excellent, though less cheap than in other parts of India, as at Bengal especially; yet in that place, though the cattle and poultry are bought originally at a very low rate, they turn out very dear by the time they are fed for the table. Here, however, all kinds of eatables may be had at a reasonable price, ready for immediate use, and as good as can be found anywhere. The wheat of Surat is famous all over India for its singular substance, whiteness, and taste; and its salads and roots are likewise of an excellent quality. There are also many kinds of wild-fowl and other game to be had at an easy rate; but for wines and spirituous liquors they depend mostly on importation.

Surat was surrounded with a wall in a short time after it had assumed the form of a town. The fortification, however, was meant only to prevent the incursions of the Mahrattas, who had twice pillaged it; so that the place was by no means capable of standing any regular siege. Even the castle appears but a poor defence, being mounted with cannon here and there, without any order, or without any thing like an attempt towards military architecture.

In this city, before the East India Company became invested with the possession of Bombay, was the presidency of their affairs on the western coast. For this purpose they had a factory established there with great privileges by the Mogul government; and even after the presidency was established at Bombay, they continued a factory here at one of the best houses in the city; which yet not being spacious enough to contain their effects, they hired another at some distance from it, and nearer the water-side, which was called the new factory. In the mean time, the city flourished, and became the centre of all the Indian trade, being much more frequented for the sake of foreign merchandise than for either the natural productions or manufactures of the country, though they also made a considerable part of its commerce. In short, there was scarce any article of merchandise but what was to be found at all times in Surat, almost as readily as in London itself. While the Mogul government was in its vigour, there was such a show of justice kept up, as induced merchants of all religions and denominations to take up their residence in the city. The Gentoos especially resorted thither, in order to avoid the oppressions of their own government. Great care indeed was taken that no very flagrant acts of oppression should be committed; so that, in what sometimes happened, appearances were at least kept up; and the oppressions of government were chiefly owing to the animosities and rivalship of the merchants themselves. As an instance of the great extent to which commerce was pushed in Surat, we shall here quote from Mr Grose, what is said by Captain Hamilton of a merchant named *Abdulgafour*, viz. "That he drove a trade equal to the East India Company: for he had known him fit out in a year above 20 sail of ships, between 300 and 800 tons, none of which had less of his own stock than 20,000l. and some of them 25,000l." On the decease of this merchant, the government seized on a million of his money; and his grandson was not only deprived of all that he possessed, but barbarously murdered through the envy and treachery of his brother merchants, and the rapacity of the governor. The imports of this city in the year 1811 amounted to 4,881,410 rupees, and the exports to 3,964,523.

The city of Surat was taken and ruined by the Portuguese in 1520; and it was not till after this misfortune that it became such a celebrated emporium. All the Indian merchants who had been accustomed to trade thither contributed to re-establish it; but it was not till near a century after that it became the general staple of

Indian

Surat, Surcharge. Indian and European merchandise; when the Dutch appearing in the Indian ocean, had deprived the Portuguese of all their conquests on that coast, and almost entirely ruined their trade. The English established a factory here in 1609, the Dutch in 1616, and the French in 1665. In process of time, the Indian seas being greatly infested by pirates, a naval officer was appointed by the Mogul to keep them in awe. This officer was named *Siddee* (A) *Mussoot*, who had been chief of an Ethiopian colony settled at Rajapore. Here he had collected some vessels of considerable force, and carried on some trade, till he was dispossessed by the Mahrattas; upon which he repaired to Bombay, and afterwards to Surat, where he was appointed admiral on that station to the Mogul, with a yearly revenue of about 36,000l. sterling. Though he had no power, independent of the marine, he seized on the castle, encroached on the town, and appropriated to himself a third part of its revenues, under pretence of arrears due in his appointed revenue. Another third was paid to the Mahrattas, to prevent their depredations upon trade in the open country; but they, not satisfied with this stipulation, watched an opportunity to plunder the town, which was kept in subjection by Siddee Mussoot, till his death which happened in 1756.

Siddee Mussoot was succeeded by his son, who soon rendered himself very disagreeable to the inhabitants. In 1758, the English factory was greatly oppressed by him, and the black merchants treated still worse; on which an expedition was sent, under Admiral Pococke and Captain Maitland, to take the castle by force. This was accordingly accomplished. Captain Maitland took possession of the castle with its revenue in the name of the East India company. The Nabob, however, was continued in office till 1800, when his authority was set aside, and the town put under the immediate government of the British. In 1803 the Mahrattas were compelled to abandon their vexatious claims, and the vicinity of the city has been cleared of those armed bands of thieves who formerly infested it.

SURCHARGE OF THE FOREST, is when a commoner puts more beasts in the forest than he has a right to. See FOREST.

SURCHARGE of Common, is a disturbance of common of pasture, by putting more cattle therein than the pasture and herbage will sustain, or the party hath a right to do. This injury can only happen where the common is appendant or appurtenant, and of course limitable by law; or where, when in gross, it is expressly limited and certain; for where a man hath common in gross, *sans nombre*, or without stint, he cannot be a surcharge. In this case indeed there must be left sufficient for the lord's own beasts.

The usual remedies for surcharging the common are by the lord's distraining the surplus number, or by his bringing an action of trespass, or by a special action on the case, in which any commoner may be plaintiff. The ancient and most effectual method of proceeding is by writ of admeasurement of pasture.

Writ of Second SURCHARGE, de secunda superoneratione, is given by the statute of Westm. 2. 13 Edw. I. cap. 8. when, after the admeasurement of pasture hath ascertained the right, the same defendant surcharges the common again; and thereby the sheriff is directed to inquire by a jury whether the defendant has in fact again surcharged the common; and if he has, he shall then forfeit to the king the supernumerary cattle put in, and also shall pay damages to the plaintiff. Surcharge ‖ Surf.

SURCINGLE, a girdle wherewith the clergy of the church of England usually tie their cassocks. See GIRDLE.

SURCOAT, a coat of arms, to be worn over body armour.

The surcoat is properly a loose thin taffety coat, with arms embroidered or painted on it. Such as is worn by heralds, anciently also used by military men over their armour to distinguish themselves by.

SURD, in *Arithmetic* and *Algebra*, denotes any number or quantity that is incommensurable to unity: otherwise called an *irrational number* or *quantity*. See ALGEBRA, Part I. Chap. IV.

SURETY, in *Law*, generally signifies the same with BAIL.

SURF, is a term used by seamen to express a peculiar swell and breaking of the sea upon the shore. It sometimes forms but a single range along the shore, and at others three or four behind one another extending perhaps half a mile out to sea. The surf begins to assume its form at some distance from the place where it breaks, gradually accumulating as it moves forward till it gains not uncommonly, in places within the limits of the trade-winds, a height of 15 or 20 feet, when it overhangs at top, and falls like a cascade with great force and a prodigious noise. Countries where surfs prevail require boats of a particular construction very different from the greater part of those which are built in Europe. In some places surfs are great at high, and in others at low water; but we believe they are uniformly most violent during the spring-tides.

It is not easy to assign the cause of surfs. That they are affected by the winds can hardly be questioned; but that they do not proceed from the *immediate* operation of the wind in the places where they happen, is evident from this circumstance, that the surf is often highest and most violent where there is least wind, and *vice versa*. On the coast of Sumatra the highest are experienced during the south-east monsoon, which is never attended with such gales as the north-west. As they are most general in the tropical latitudes, Mr Marsden, who seems to have paid much attention to the subject, attributes them to the trade-winds which prevail at a distance from shore between the parallels of 30 degrees north and south, whose uniform and invariable action causes a long and constant swell, that exists even in the calmest weather, about the line, towards which its direction tends from either side. This swell, when a squall happens or the wind freshens up, will for the time have other subsidiary waves on the extent of its surface, breaking often in a direction contrary to it, and which will again subside as a calm returns, without having produced

(A) When the Abyssinian slaves are promoted to any office under the Mogul government, they are called *Siddees*.

Surf ‖ Surfeit.

duced on it any perceptible effect. Sumatra, though not continually exposed to the south-east trade-wind, is not so distant but that its influence may be presumed to extend to it; and accordingly at Poolo Pesang, near the southern extremity of the island, a constant southerly sea is observed, even after a strong north-west wind. This incessant and powerful swell rolling in from an ocean, open even to the pole, seems an agent adequate to the prodigious effects produced on the coast; whilst its very size contributes to its being overlooked. It reconciles almost all the difficulties which the phenomena seem to present, and in particular it accounts for the decrease of the surf during the north-west monsoon, the local wind then counteracting the operation of the general one: and it is corroborated by an observation, that the surfs on the Sumatran coast ever begin to break at their southern extreme, the motion of the swell not being perpendicular to the direction of the shore. This explanation of the phenomena is certainly plausible; but, as the author candidly acknowledges, objections may be urged to it. The trade-winds and the swell occasioned by them are remarkably steady and uniform; but the surfs are much the reverse. How then comes an uniform cause to produce unsteady effects?

In the opinion of our author it produces no unsteady effects. The irregularity of the surfs, he says, is perceived only within the remoter limits of the trade-winds. But the equatorial parts of the earth performing their diurnal revolution with greater velocity than the rest, a larger circle being described in the same time, the waters thereabout, from the stronger centrifugal force, may be supposed more buoyant; to feel less restraint from the sluggish principle of matter; to have less gravity; and therefore to be more obedient to external impulses of every kind, whether from the winds or any other cause.

SURFACE. See SUPERFICIES.

SURFEIT, in *Medicine*, a sickness with a sensation of a load at the stomach, usually proceeding from some error in diet, either with regard to the quantity or quality of the food taken. Sometimes, however, a surfeit is only a plethora from indolence and full diet: in which case perspiration is defective; and eruptions appear on the skin.

Fasting for some time, and an attention to temperance afterwards, with some brisk purgatives, will generally remove the effects of a surfeit, when it is unaccompanied with other more permanent affections.

SURFEIT, in *Farriery*. See FARRIERY *Index*.

SURGE, in the sea-language, the same with a wave. See WAVE.

SURGEON, or CHIRURGEON, one that professes the art of SURGERY.

In England there are two distinct companies of surgeons now occupying the science or faculty of surgery; the one company called *barbers*, the other *surgeons*, which latter are not incorporated.—The two are united to sue, and be sued, by the names of masters or governors and commonalty of the mystery of barbers and surgeons of London. 32 Hen. VIII. c. 42.

No person using any barbery or shaving in London, shall occupy any surgery, letting of blood, or other matter; drawing of teeth only excepted. And no person using the mystery or craft of surgery shall occupy or exercise the feat or craft of barbery or shaving, neither by himself, nor any other for his use. 32 Hen. VIII. c. 42.

By the same statute, surgeons are obliged to have signs at their doors.

The French chirurgeons being refused to be admitted into the universities (notwithstanding that their art makes a branch of medicine), on pretence of its bordering a little on butchery or cruelty, associated themselves into a brotherhood, under the protection of S. Cosmus and S. Damian: on which account, according to the laws of their institution, they are obliged to dress and look to wounds *gratis* the first Monday of each month.

They distinguish between a chirurgeon of the long robe and a barber-chirurgeon. The first has studied physic, and is allowed to wear a gown. The skill of the other, besides what relates to the management of the beard, is supposed to be confined to the more simple and easy operations in chirurgery; as bleeding, tooth-drawing, &c.

They were formerly distinguished by badges: those of the long gown bore a case of instruments; the barber, a bason.

SURGERY.

THE term Surgery has usually been employed to signify that department of medicine which treats of those diseases of the human body to be cured or alleviated by the hand, by instruments, or by external applications.

INTRODUCTION.

MEDICINE and Surgery, formerly regarded as one and the same science, were exercised by the same persons during the most remote ages; and their separation is to be considered as a modern institution.

If we consider their origin and end, the knowledge which the practitioner of each requires, and the connection which subsists between the diseases which are supposed peculiarly to belong to each department, it is probable that the first practitioners confounded them with each other; and it is easy to conceive how the same ideas should have passed from one generation to another.

At last, however, the knowledge of the healing art being greatly enlarged, it became separated into different classes, and formed into distinct departments in practice. Accordingly there were not only some who confined themselves to Surgery, but there were Lithotomists, Phlebotomists, Oculists, Aurists, Dentists, &c.

It is not proposed here to enter into any detail in attempting to show how this separation was made, and still less to mention the puerile disputes regarding the pre-eminence of Medicine to Surgery. There are

are few we believe in our days who do not feel that such a pre-eminence does not exist; that medicine and Surgery are one and the same science; that they are coeval with the human race; and to those who are able to appreciate them, they must appear of equal utility and importance. The healing art is one, its principles are the same throughout, and the exercise of its different branches supposes the same fundamental knowledge; but it offers in the detail such a vast field, that few men are able to embrace the whole, and to cultivate all the parts with equal success. It becomes, therefore, an advantage to society that such parts as can easily be separated in practice be exercised by different individuals; and that a man after having acquired a general knowledge of the structure, functions, and diseases of the animal economy, practise in such departments as his talents and acquirements point out.

Some have opposed Surgery to medicine by qualifying the first with the name of art, and in giving to the second that of science. To pretend that Surgery is nothing but the art of treating diseases by external means or by manual operations, is to rank it among the mechanical professions; and to consider the man as a good surgeon who can merely dress an ulcer, apply a bandage, reduce a fracture, amputate a limb, or only perform such like operations, on the living body. We have already mentioned that the healing art is the same in all its branches; the internal organs of the body in a state of health are governed by the same general laws; many of them are analogous in structure to the external parts; and the nature of a local disease can never be understood if we are not acquainted with all the deviations from the natural state, of which the whole animal system is susceptible. If a physician be called to treat a pleurisy, he cannot expect to do so with success unless he have a sufficiently clear idea of the nature of inflammation, or at least of the principal symptoms which characterise it; of its consequences, and of the proper mode of applying the means to remove it. But all this knowledge is not less necessary to the Surgeon who has to treat an wound, the management of which depends chiefly on the precautions necessary to prevent and remove inflammation in the affected parts, without at the same time weakening too much the vital powers. The knowledge of the physician does not therefore merit more the name of *science*, than that of the Surgeon, who ought to be well acquainted with the structure and functions of the animal economy, with morbid changes, and with the progress and termination of diseases.

The student of Surgery has therefore to acquire, not only all that knowledge necessary for the well educated physician, but he has likewise to learn the manner of performing surgical operations. This, though no doubt an essential requisite to the Surgeon, is by no means so important as a competent knowledge of those diseases and states of disease which require such means; and the young Surgeon should endeavour not to cherish that love of operating which is observed in some, and which arises from the eclât which a dexterous operator generally receives.

To become an intelligent and expert operator, several qualifications are necessary; some of which fall to the lot of few individuals. There are many, who, though they have acquired an extensive knowledge of diseases, have not that calmness of mind, that collectedness of thought, which is necessary for a good operator; and there are some who are even deficient in the mechanical dexterity, which, though not requisite in all, is yet necessary in several of the operations of Surgery. These talents, however, are never given in such perfection as not to require cultivation. An early habit of being present, and of assisting at operations, prepares the student to act for himself; and a long and unremitting habit of using the knife, and of performing operations on the dead body, gives a facility in all the mechanical parts, which even experience on the living body does not procure.

History of Surgery.

That Surgery was not only coeval with the other branches of medicine, but antecedent to any of them, will not admit of doubt. The wars and contentions which have taken place among mankind ever since their creation, imply that there would be occasion for Surgeons at a very early period; and probably external injuries would for some time be the only diseases for which a cure would be attempted, or perhaps thought practicable. In the sacred writings is made much mention of balsams, particularly the balm of Gilead, as excellent in the cure of wounds; though at the same time there were some wounds which this balsam could not heal.

Concerning the Surgery practised among the Egyptians, Jews, and Asiatic nations, there is little known. The art descended from the Greeks to us, though they confessedly received it from the Eastern nations. The first Greek surgeons on record are Æsculapius and his sons Podalirius and Machaon. Æsculapius flourished about 50 years before the Trojan war; and his two sons distinguished themselves in that war both by their valour and by their skill in curing wounds. This indeed is the whole of the medical skill attributed to them by Homer; for in the plague which broke out in the Grecian camp, he does not mention that they were at all consulted. Nay, what is still more strange, though he sometimes mentions his heroes having their bones broke, he never takes notice of their being reduced or cured by any other than supernatural means; as in the case of Æneas, whose thigh-bone was broken by a stone cast at him by Diomed. The methods which these two famous Surgeons used in curing the wounds of their fellow soldiers, seems to have been the extracting or cutting out the darts which inflicted them, and applying emollient fomentations or styptics to them when necessary. To these they attributed much more virtue than they could possibly possess; as appears from the following lines, where Homer describes Eurypylus wounded and under the hands of Patroclus, who would certainly practise according to the directions of the Surgeons.

> Patroclus cut the forky steel away;
> Then in his hand a bitter root he bruis'd,
> The wound he wash'd, the styptic juice infus'd.
> The *closing flesh* that instant ceas'd to glow;
> The wound to torture, and the blood to flow.

Till the days of Hippocrates we know very little of what was the practice of the Greek Surgeons. From him, however, we learn, that blood-letting, cupping, and scarification, were known to them; also the use of warm

History. warm and emollient fomentations, issues made with hot irons, pessaries, injections, fumigations, &c. Hippocrates also gives directions for the management of fractures, luxations, ulcers, fistulas. He directs the extension, reduction, bandages, and splints, proper to be used in fractures and luxations of different bones, with several machines to increase extension when necessary. He directs the laxity and tightness of the bandages; the intervals for unloosing and binding them on again; the position and repose of the fractured member, and the proper regimen; and he mentions the time when a callus is usually formed. He treats also of fractures of the skull, and the method of applying the trepan. In his treatment of ulcers, he speaks of reducing fungous flesh by means of escharotics, as alum, nitre, verdigrise, quicklime, &c.

Surgery appears not to have existed in Rome, notwithstanding the warlike genius of the people, for more than 500 years. Archagathus, a Greek, was the first professor of the art in that city; and so frequently employed the knife, hot irons, and other cruel methods of cure, that he was branded with the opprobrious title of *carnifex*, and expelled the city, where no physician or surgeon of eminence again made his appearance for 180 years. At this time Asclepiades undertook the profession of medicine; but seems to have attended little to surgery. Neither have we any thing of importance on that subject till the time of Celsus, who flourished during the reigns of Augustus and Tiberius.—In his work on surgery, all the improvements from Hippocrates to his own days are collected; the most minute and trifling diseases not being omitted. An eminent surgeon, of the moderns, emphatically exhorts every person in that profession "to keep Celsus in his hands by day and by night." Celsus describes the signs of a fractured skull, the method of examining for the fracture, of laying the skull bare by an incision in the form of the letter X, and afterwards of cutting away the angles, and of applying the trepan, mentioning also the signs of danger and of recovery. He observed, that sometimes, though very rarely, a fatal concussion of the brain might happen from the blood-vessels within the skull being burst, the bone remaining entire. After the operation of the trepan, sponges and cloths wetted with vinegar, and several other applications, were made to the head; and, throughout, severe abstinence was enjoined. In violent fractures of the ribs, he ordered venesection; low diet; to guard against all agitation of the mind, loud speaking, motion, and every thing that might excite coughing or sneezing. Cloths wetted with wine, roses and oil, and other applications, were laid over the fracture. The cure of fractures, in the upper and lower extremities, he said were nearly alike; that fractures differ in degree of violence and danger, in being simple or compound, that is, with or without a wound of the flesh, and in being near to the joint. He directs the extension of the member by assistants; the reduction, by the surgeon's hands, of the fractured bones into their natural situation; and to bind the fractured part with bandages of different lengths, previously dipped in wine and oil: on the third day fresh bandages ought to be applied, and the fractured member fomented with warm vapour, especially during the inflammation. Splints, if necessary, are to be applied, to retain the bones in a fixed position. The fractured arm is to be suspended in a broad sling hung round the neck: the fractured leg is to be inclosed in a kind of case, reaching above the ham, and accommodated likewise with a support to the foot, and with straps at the side, to keep the leg steady: in the fractured thigh-bone, the case is to extend from the top of the hip to the foot. He describes the method of treating compound fractures, and of removing small fragments of splinters of bones; and the manner of extracting darts. In luxations of the shoulder, he mentions several methods of giving force to the extension, and of replacing the dislocated bone. One method similar to that of Hippocrates was, to suspend the patient by the arm; the fore part of the shoulder, at the same time, resting upon the top of a door, or any other such firm fulcrum. Another method was to lay the patient supine, some assistants retaining the body in a fixed position, and others extending the arm in the contrary direction; the surgeon, in the mean time, attempting, by his hands, forcibly to reduce the bone into its former place.

If much inflammation was expected to ensue after a wound, that was suffered to bleed for some time, and blood was drawn from the arm. To wounds accompanied with considerable hæmorrhagy, he applied a sponge wet in vinegar, and constant pressure: If necessary, on account of the violence of the hæmorrhagy, ligatures were made round the vessels, and sometimes the bleeding orifice was seared up with the point of a hot iron. On the third day fresh dressings were applied. In considerable contusions, with a small wound of the flesh, if neither blood-vessels nor nerves prevented, the wound was enlarged. Abstinence and low diet, upon all such accidents, were prescribed; cloths wet with vinegar, and several other applications, were to be applied to the inflamed part. He observes, that fresh wounds may be healed without compound applications. In external gangrene, he cut into the sound flesh; and when the disease, in spite of every effort, spread, he advised amputation of the member. After cutting to the bone, the flesh was then separated from it, and drawn back, in order to save as much flesh as possible to cover the extremity of the bone. Celsus, though extremely diffuse in the description of surgical diseases, and of various remedies and external applications, treats slightly of the method of amputating; from which, comparing his treatise with the modern systems, we might infer that the operation was then seldomer practised than at present. He describes the symptoms of that dangerous inflammation the carbuncle, and directs, to burn or corrode the gangrened part. To promote the suppuration of abscesses, he orders poultices of barley-meal, or of marshmallows, or the seeds of linseed and fenugreek. He also mentions the compositions of several repellent cataplasms. In the Erisipelas, he applies ceruse, mixed with the juice of solanum or nightshade. Sal ammoniac was sometimes mixed with his plasters.

He is very minute in describing diseases of the eyes, ears, and teeth, and in prescribing a multitude of remedies and applications. In inflammation of the eyes, he enjoined abstinence and low diet, rest, and a dark room: if the inflammation was violent, with great pain, he ordered venesection, and a purgative; a small poultice of fine flower, saffron, and the white of an egg, to be laid to the forehead to suppress the flow of pituita; the soft inside of warm wheat bread dipped in wine, to be laid to the eye; poppy and roses were also added to his

his collyriums, and various ingredients too tedious to enumerate. In chronic watery defluxions of the eyes, he applied astringents, cupped the temples, and burnt the veins over the temple and forehead. He couched cataracts by depressing the crystalline lens to the bottom of the orbit. Teeth, loosened by any accident, he directs, after the example of Hippocrates, to be fastened with a gold thread to those adjoining on each side. Previous to drawing a tooth, he ordered the gum to be cut round its neck; and if the tooth was hollow, it was to be filled with lead before extraction, to prevent its breaking by the forceps. He describes not only the inflammation, but likewise the elongation, of the uvula: he also describes the polypus, and some other diseases affecting the nose.

He describes several species of herniæ or rupture, and the manual assistance required in those complaints. After the return of the intestines into the abdomen, a firm compress was applied to that part of the groin through which they protruded, and secured by a bandage round the loins. In some cases, after the return of intestinal ruptures, he diminished the quantity of loose skin, and formed a cicatrix, so as to contract over the part, to render it more rigid and capable of resisting. He describes various diseases of the genital parts; the hydrocele or dropsy of the scrotum, a difficulty of making urine, and the manner of drawing off the water by a catheter; the symptoms of stone in the bladder, and the method of sounding or feeling for the stone. Lithotomy was at that time performed by introducing two fingers into the anus; the stone was then pressed forward to the perinæum, and a cut made into the bladder; and by the finger or scoop the stone was extracted. He describes the manner of performing this operation on both sexes, of treating the patient, and the signs of recovery and of danger.

Celsus directed various corrosive applications and injections to fistulas; and, in the last extremity, opened them to the bottom with a knife, cutting upon a grooved instrument or conductor. In old callous ulcers, he made a new wound, by either cutting away the hard edges, or corroding them with verdigrise, quicklime, alum, nitre, or with some vegetable escharotics. He mentions the symptoms of a caries in the bone; directs the bone to be laid bare, and to be pierced with several holes, or to be burnt or rasped, in order to promote an exfoliation of the corrupted part; afterwards to apply nitre and other ingredients. One of his applications to cancer was auripigmentum or arsenic. He directs the manner of tapping the abdomen in ascites, and of drawing blood by the lancet and cupping-glasses. His cupping-glasses were made either of brass or horn, and were unprovided with a pump. He cured varicose veins by ustion or by incision. He gives directions for extracting the dead fœtus from the womb, in whatever position it should present; and, after delivery, to apply to the private parts soft cloths wet in an infusion of vinegar and roses.

In Celsus's works there is a great variety of plasters, ointments, escharotics, collyriums, of suppurating and discutient cataplasms, and external applications of every kind, both simple and compound: Perhaps, amongst the multitude there are a few useful remedies now laid aside and neglected.

The last writer of consequence who flourished at Rome was Galen, physician to the emperor Marcus Aurelius. His works are for the most part purely medical; although he wrote also on Surgery, and made Commentaries on the Surgery of Hippocrates. He opened the jugular veins and performed arteriotomy at the temples; and he used leeches, scarification, and cupping-glasses, to draw blood. He also described with accuracy the different species of herniæ or ruptures.

In the year 500 flourished Aëtius, in whose works are met with many observations omitted by Celsus and Galen, particularly on the surgical operations, the diseases of women, the causes of difficult labours, and modes of delivery. He also takes notice of the dracunculus, or Guinea worm. Aëtius, however, was greatly excelled by Paulus Egineta, who flourished in 640; and whose treatise on Surgery is superior to that of all the other ancient writers. He directs how to extract darts; to perform the operation sometimes required in dangerous cases of rupture or hernia. He treats also of aneurism. Galen, Paulus, and all the ancients, speak only of one species of aneurism, and have defined it to be "a tumor arising from arterial blood extravasated from a ruptured artery." The aneurism from a dilatation of the artery is a discovery of the moderns. In violent inflammations of the throat, where immediate danger of suffocation was threatened, Paulus performed the operation of bronchotomy. In obstinate defluxions upon the eyes, he opened the jugular veins. He describes the manner of opening the arteries behind the ears in chronic pains of the head. He wrote also upon midwifery. Fabricius ab Aquapendente, a celebrated surgeon of the 16th century, has followed Celsus and Paulus as text books.

From the time of Paulus Egineta to the year 900, no writer of any consequence, either on medicine or Surgery, appeared. At this time the Arabian physicians Rhazes and Avicenna revived in the east the medical art, which, as well as others, was then almost extinguished in the west. Avicenna's *Canon Medicinæ*, or General System of Medicine and Surgery, was for many ages celebrated through all the schools of physic. It was principally compiled from the writings of Galen and Rhazes. The latter had correctly described the spina ventosa, accompanied with an enlargement of the bone, caries, and acute pain. In difficult labours, he recommends the fillet to assist in the extraction of the fœtus; and for the same purpose, Avicenna recommends the forceps. He describes the composition of several cosmetics to polish the skin, and make the hair grow or fall off.

Notwithstanding this, however, it was not till the time of Albucasis that Surgery came into repute among the Arabians. Rhazes complains of their gross ignorance, and that the manual operations were performed by the physicians servants. Albucasis enumerates a tremendous list of operations, sufficient to fill us with horror. The hot iron and cauteries were favourite remedies of the Arabians; and, in inveterate pains, they reposed, like the Egyptians and eastern Asiatics, great confidence in burning the part. He describes accurately the manner of tapping in ascites; mentions several kinds of instruments for drawing blood; and has left a more ample and correct delineation of surgical instru-

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ments than any of the ancients. He gives various obstetrical directions for extracting the fœtus in cases of difficult labour. He mentions the bronchocele, or prominent tumor on the neck, which, he tells us, was most frequent among the female sex. We are also informed by this writer, that the delicacy of the Arabian women did not permit male surgeons to perform lithotomy on them; but when necessary, it was executed by one of their own sex.

From the 11th century to the middle of the 14th, the history of Surgery affords nothing remarkable except the importation of that nauseous disease the leprosy into Europe.

Towards the end of the 15th century the venereal disease is said to have been imported from America by the first discoverers of that continent.

At the beginning of the 16th century, Surgery was held in contempt in this island, and was practised indiscriminately by barbers, farriers, and sow-gelders. Barbers and surgeons continued, for 200 years after, to be incorporated in one company both in London and Paris. In Holland and some parts of Germany, even at this day, barbers exercise the razor and lancet alternately.

It is within the last three centuries that we have any considerable improvement in Surgery; nor do we know of any eminent British surgical writers, until within the last 130 years. "In Germany (says Heister) all the different surgical operations, at the beginning even of the 18th century, were left to empirics; while regular practitioners were contented to cure a wound, open a vein or an abscess, return a fractured or luxated bone; but they seldom or never ventured to perform any of the difficult operations."

Sixteenth century.

The first surgical work of the 16th century worthy of notice is that of J. Carpus. F. ab Aquapendente, an Italian, published a System of Surgery, containing a description of the various diseases, accidents, and operations. Boerhaave pays this author the following compliment: *Ille superavit omnes, et nemo illi hanc disputat gloriam; omnibus potius quam hocce carere possumus.* About the same period, A. Parey, a Frenchman, made several important additions to Surgery, particularly in his collection of cases of wounds, fractures, and other accidents which occur during war. The ancients, ignorant of powder and fire-arms, were defective in this part of military surgery. Parey pretends to have first invented the method of tying with a needle and silk-thread the extremities of large arteries, after the amputation of a member. The ligature of the blood-vessels is, however, merely a revival of the ancient practice, which had fallen into disuse: Throughout the dark ages, the hot iron, cauteries, and strong astringents, were substituted in its place. B. Maggius and L. Botellus wrote on the cure of gunshot wounds. J. A. Cruce wrote a system of Surgery.

In the 17th century, Surgery was enriched with several systems, and with detached or miscellaneous observations. The principal authors are, M. A. Severinus, V. Vidius, R. Wiseman, Le Clerc, J. Scultetus, J. Mangetus, C. Magatus, Spigellius, F. Hildanus, T. Bartholin, P. de Marchett.

Eighteenth century.

During the last century, Surgery, like all the other sciences, made more rapid progress toward perfection, than during all the preceding periods. This partly arose from the assistance of governments in the different countries. They being convinced that anatomy is one of the most necessary sciences, and the groundwork of the whole healing art, but particularly of Surgery; in many great cities academies were instituted for the cultivation of practical anatomy; and schools were also established for the instruction of the theoretical and practical parts of Surgery.

These improvements in Surgery were chiefly made in England, France, and Germany; and in all these countries a number of very eminent men have since appeared.

The English surgeons, besides possessing an accurate knowledge of anatomy, and great abilities in the operative part of their profession, were the first who endeavoured to bring the art to its present simplicity. They directed also their attention, in a particular manner, to the medical treatment and diet of patients; the neglect of which had caused the unfortunate issue of many operations which had been dexterously performed.

Among the surgeons of later times, we may first mention the name of *Sharp*. He was a scholar of Cheselden, and one of the best surgeons of his day. He wrote a Compendium of Surgical Operations, 1746; and also a Critical Inquiry into the State of Surgery; both of which works are still in high estimation.

In the year 1719, *Dr Monro*, after visiting the schools of London, Paris, and Leyden, where he was a pupil of the great Boerhaave, came to Edinburgh; and this may be considered as the date of the foundation of the Edinburgh medical school. He began by giving lectures on Anatomy and Surgery, the first which were delivered in Edinburgh; and in the year 1721 he was appointed professor of Anatomy and Surgery to the university. This eminent anatomist and surgeon, besides filling his chair with the greatest reputation, contributed to the advancement of our knowledge in many important parts of Anatomy and Surgery. His works, published by his son, besides his Treatise on Osteology, which is certainly the best description of the bones that has ever been given, will be found to contain many interesting and valuable observations on various surgical diseases.

Joseph Warner, surgeon of Guy's Hospital, in London, published his Cases and Remarks in Surgery, in the year 1754, a work which contains many very important practical remarks. He afterwards published a very good work, containing a description of the human Eye and its adjacent parts, in which he particularly rejects the fastening of the eye during the operation of cataract. He also published An Account of the Testicles, their Common Coverings and Coats, &c.

Percival Pott, surgeon of St Bartholomew's Hospital, may be justly considered as one of the principal English surgeons of his time. He was not only a successful practitioner, but an industrious and excellent though diffuse writer. The merits of Pott are indeed considerable. He threw much light on the doctrine of wounds of the head, by his accurate arrangement of the different kinds of injuries to which the head is subject. He also gave a good account of hydrocele and the other diseases of the testicle. On the operation of the fistula in ano, he made material improvements. He has given many useful hints on fractures and dislocations; and he was a great champion in favour of the operation for cataract by couching. He was the first person who described

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described the chimney-sweeps cancer; and on herniæ, polypus, and curvatures of the spine, he has made many judicious pathological and practical observations.

Charles White, surgeon in Manchester, published an excellent practical work in the year 1770, in which he recommends amputation of the foot, a little above the ankle joint, instead of under the knee, as had usually been practised. He also shows the effect of sawing off the ends of bones; and discusses several other interesting points in surgery. In the same year, *Mr Else* of St Thomas's Hospital, published his treatise on the hydrocele, in which he recommends the use of caustic in the cure of that disease.

In the year 1770, *Mr Dease*, of Dublin, wrote an excellent treatise on the wounds of the head. *Mr Bromfield*, of St George's Hospital, and *Mr Hill*, surgeon at Dumfries, also distinguished themselves; Mr Bromfield for his Chirurgical Observations, and Mr Hill for his Observations on Cancers.

In the year 1778, *Mr Benjamin Bell* published the first volume of his System of Surgery. The reputation of this work was soon such, that it was translated into the French and German languages; and it has since gone through several editions in these, and many in English.

This work presented the most complete System of Surgery which had ever appeared; and in every part of it there is displayed a talent for practical observation and clearness of thought which must render it ever a useful and valuable present to Surgery. Like all such extensive works, it is not without faults, and the language in which it is written is in some places prolix and diffuse; but notwithstanding all its errors, it certainly must be considered as the most useful body of Surgery that ever had appeared in this country.

Besides these, mention must be made of two other eminent surgeons, *William* and *John Hunter;* the former rendered immortal by his splendid work on the gravid uterus; and the latter by his treatise on the venereal disease, and also his treatise on the blood, inflammation, and gun-shot wounds.

Many very eminent men arose, both in France and Germany, during the last century. The transactions of their academies leave a lasting monument of their zeal and industry.

In France we have the names of Petit, Arnaud, Garangeot, Morand, Le Dran, Le Cat, Louis, David Levret, Le Blanc, De la Faye, David Chopart, Dessault, Janin, Jourdain, Pouteau, André Lombard Wensel.

In Germany, Surgery has been enriched by the works of Vogel, Platner, Albert Haller, Bilguer, Weitz, Seibold, Brambilla, Theden, Smucker, Stork, Plenk, Isenflamm, Rougemont, Conradi, and Richter.

Arrangement of surgical diseases.

Most authors who have written systems of Surgery have described diseases according to the parts of the body where they were situated; beginning with the head, and describing the organs in succession, according to their situation.

Besides this mode of arrangement being unphilosophical, it has many serious disadvantages. Diseases which have no analogy to each other, are treated of in the same place; and similar diseases are treated of separately, instead of being classed together, and considered in one general point of view, thus causing a repetition of what may be considered as the generic characters of the disease. The utility of nosological systems in practical medicine and in pathology, is indispensable. Diseases which have common characters are thus brought together, and arranged under classes, orders, genera, and species. Nosology is, therefore, to be considered as an important step in order to facilitate the means of acquiring knowledge of the diseases of the human body, and to give clear and comprehensive views of them; for it is equally important, to be able to distinguish diseases, as to point out how they should be treated.

All nosological writers have not, however, constructed their systems on similar principles; and their efforts have been often frustrated by the false theories and hypotheses with which they have set out.

Bichât's views of the structure of the body.

The world is indebted to the ingenious and celebrated *Bichât*, for the first truly philosophical view of the structure of the human body. The simple division of it into its component parts, which that great anatomist and philosopher pointed out, must be considered as the groundwork of all future anatomical and pathological inquiries.

Bichât demonstrated, that most of the organs of our body are made up of a variety of elementary parts or *textures;* each of which, in whatever organ it is found, uniformly has the same physical properties, and present the same morbid phenomena. These he considers as the elementary parts; which, by the diversity of their combinations, produce all the modifications of structure and functions exhibited in the different organs of animals. This method of considering organized bodies, accords with every phenomenon with which we are acquainted, and seems to arise from the essential nature of their constitution. We may trace this view of the structure of the body in the observations of many of the older anatomists; and particularly it may be considered as the basis of some of the most ingenious philosophical theories of the late ingenious Mr John Hunter.

In order to fix the characters of the elementary textures, Bichât employed various modes of inquiry. He performed numerous experiments on living animals; persevered in tedious and minute dissections; employed chemical reagents to supply the place of the knife; and examined with minuteness all the varieties of morbid structure. Having by these means accomplished his object in tracing the character of each separate texture, he next proceeded to investigate their combinations as they are found in the different organs.

Their application to pathology.

The effects of this mode of analyzing the structure of the human body when diseased, must be at once obvious. We learn from it, that diseases at their commencement are generally confined to one texture of an organ; the other textures of which the organ is composed remaining sound.

There is no organ of the body from which this important truth may not be deduced. It may be readily illustrated from considering the diseases of the mucous, serous, and muscular textures, which compose the stomach and alimentary canal; the cellular texture of the lungs; the mucous membrane of the bronchi, the serous one of the pleura, and many others.

But diseases are not only confined to one individual texture of any organ, as in the cases just mentioned; the symptoms and morbid changes are likewise uniformly the same in textures of a similar structure, in whatever parts

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parts of the body these textures may happen to be found. Thus the serous membranes which invest the lungs, the brain, the heart, the abdominal viscera, have one common character when affected with any specific disease: so also have the mucous membranes, whether in the mouth, the nose, the vagina, the urethra, or covering the eye-ball; and the same may be observed of every individual texture which enters into the composition of our bodies.

Besides the symptoms and morbid changes which are common to all textures whose structure is similar in the natural state, there are others which are determined from the particular functions of the organ in which the diseased texture exists. For example, when any of the serous membranes are inflamed, the nature of the pain, the degree of fever, and the duration of the symptoms, are the same, in whichsoever it may have taken place. But to these symptoms are added, cough, difficulty of breathing, when it happens to be connected with the organs of respiration, as in the case of pleuritis; costiveness, strangury, delirium, loss of vision, when the intestines, the bladder, the brain, or the eye, are involved in the disease.

This view of the subject naturally suggests a correspondent division of the symptoms. The first class are general, and characterise a whole genus of textures; the second are in a manner accessory, and depend on the relative situation or the particular functions of the organ into the composition of which the affected texture enters.

But here we must set bounds to this theory;—the history and progress of diseases shew, that we ought not to confine our observations within such narrow limits. The principles which have been stated, indeed, account admirably well for the propagation of some affections, and for some of the sympathies which subsist between different parts of the body; but there are other disorders which advance in a very different manner. In some diseases which are termed chronic, for example, the whole structure of an organ becomes gradually altered, although the primary affection be confined to one of its component textures. This is often to be observed in cancer, scrofula, and lues venerea. When cancer attacks the mamma, it is at its commencement generally confined to a small portion of that gland; but if allowed to proceed, it ultimately involves the whole gland, and the adjacent cellular and cutaneous textures, in one mass of disease.

These general observations will be sufficient to give an outline of the principles of a pathological system, founded on the basis of anatomical knowledge; and in giving an account of those diseases which more properly belong to a system of surgery, we have ventured to apply these principles. We shall, in the first place, therefore, consider the diseases of the Cellular Membrane; the diseases of the Skin; of the Mucous, Serous, and Sinovial membranes; of Bone and Cartilage; of the Vascular and Nervous systems; and of the Glands. In the second place, we shall treat of diseases which occur only in particular organs, whether from the peculiarity of their structure or functions: such are the diseases of the eyes, ears, nose, teeth, mouth, and fauces, and the organs of urine and generation. In the third place, we shall take notice of malconformations, distortions, and protrusions; and in the last place, of wounds, fractures, dislocations, and such operations as are occasionally necessary to be performed on different parts of the body, as amputation, sutures, &c,

Chap. I.

Of the Diseases of the Cellular Membrane.

Sect. I. *General Remarks on the Pathology of the Cellular Membrane.*

The cellular membrane is distinguished from other textures, by the power which it has of throwing out granulations, by its being capable of elongation, of reproduction, and of growth when it has been divided*. Suppuration also takes place in the cellular membrane, with a rapidity of which there are few examples in other textures. The fluid which is the result of this suppuration, is well known. Its colour, its consistence, and all its external qualities, have become the criterion by which we form our ideas of *pus;* in consequence of which, all discharges which do not resemble it, have been commonly considered as pus of a bad kind, or as *sanies.* This opinion, however, is false; and has been formed in consequence of a too superficial view of the different circumstances attending different kinds of discharged fluids. Certainly the pus which is discharged from a bone, from a muscle, from the skin in erysipelas, from the mucous membranes in catarrh, is of a good kind whenever the inflammation runs through regularly its different periods, and notwithstanding it is quite different in all these cases from the pus produced by suppuration of the cellular membrane. But as the latter is most frequently observed, from it we have formed an idea of *laudable* pus, and of *sanies.* The cutaneous pus, the mucous pus, the osseous pus, &c. have all their proper sanies; which differ from one another as much as the natural structure and functions of the organs from which they are produced.

There are few parts of the body which have a greater number of exhalents than the cellular membrane; and this exposes it to various alterations of structure, such as being preternaturally distended by the different substances which it exhales; and these, sometimes presenting a solid appearance, sometimes producing a lardy substance, sometimes a gelatinous matter, and sometimes a much firmer and harder mass. The numerous absorbent vessels which are also distributed on the cellular membrane, is another cause of various diseases; every small cell being a reservoir common to the exhalents which terminate in it, and to the absorbents which arise from it.

There are some diseases, too, which produce a change in the elasticity and powers of distension, which the cellular membrane naturally possesses. In health it has enormous powers of distension, as may be observed in emphysema and anasarca; and whenever these diseases are removed, it regains its natural bulk and form. In inflammations, this property is in part destroyed, and it happens also in many of the different indurations to which it is liable. Its elasticity is also less remarkable in people advanced in life, than in children. When an old man turns quickly thin, the skin becomes flaccid, and forms

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forms into folds; but when a young man is emaciated, the skin is applied exactly to the subjacent organ, and preserves its tension.

The cellular membrane, when diseased, becomes sometimes extremely sensible, and the seat of acute pain, though it seems to possess no sensibility in its natural state. When either blood, milk, or lymph, are effused in it, its sensibility is not altered, and these fluids are absorbed. On the contrary, the sensibility is so much altered by the contact of urine, of bile, of saliva, and of the other fluids destined to be thrown out of the body, that often the inflammation which succeeds the effusion prevents their absorption.

As the cellular membrane enters into the composition of every organ, it is often difficult to distinguish in diseases what belongs to it from that which is the attribute of the other textures with which it is found. These connections, however, become manifest under several circumstances: In acute and chronic diseases it is very susceptible of being influenced by the disease of the organs. We do not speak here of the alterations produced from juxtaposition and continuity, but of those diseases which arise in parts of the cellular membrane which have no known connection with the affected organ.

In acute diseases which affect a particular organ, as the lungs, stomach, or intestines, often the cellular membrane becomes sympathetically affected and the seat of inflammation and abscesses. The greater number of critical abscesses arise from this connection which exists between the organ affected and the cellular membrane. In acute diseases too it is commonly the function of exhalation or absorption of the cellular membrane that is affected, and hence the sudden œdema which often accompanies them. In chronic diseases their influence is no less remarkable. It is well known, that in chronic diseases of the heart, of the lungs, of the liver, of the stomach, kidneys, uterus, &c. they have for their symptom during their last stages an anasarca, more or less general, which arises from debility produced in the cellular system.

We observe, that in all acute diseases, the skin receives with great facility the sympathetic influence of the diseased organ, and that it is alternately moist and dry frequently during the same day. It is by no means improbable that the cellular membrane undergoes alterations analogous to those of the skin; and if we could observe what passes in it, we might discover the cells more or less moist, more or less dry, according as it happened to be influenced: It is also to this we ought to attribute the different state of the cellular membrane, in patients who have died of acute diseases; these presenting numberless varieties in the serous effusions.

The cellular system is not only influenced by its sympathy with other organs; but it also exercises a sympathy over them. In a phlegmon or inflammation of the cellular membrane, if the tumour be considerable, often various alterations take place in the functions of the brain, of the heart, of the liver, or of the stomach. The sympathetic vomiting, &c. are those phenomena in great phlegmons which are often present without being considered as belonging to the disease.

Art avails itself of the influence of the cellular system in the diseases of other organs, in the use of *setons*. Often in the diseases of the eye and of joints a seton produces an effect which cannot be obtained by a blister; and this probably arises from the connection which exists between the cellular membrane and the eye or joint, being more active than that which exists between these organs and the skin*.

It ought to be also remarked, in considering the pathology of the cellular system, that there is a manifest difference in the properties of the cellular texture, which is composed of layers and filaments; and in that exterior to the different mucous surfaces, and to the blood-vessels and excretories, which consists of filaments alone. From this difference results the rare occurrence of inflammations and of different kinds of tumors in the latter. It often forms a barrier where the morbid affection of the former stops, and thus protects the organ which it envelopes.

* Vide *Anatomie Descriptive, par Bichat.*

The unfrequency of hemorrhagy when extensive suppurations have laid bare large arteries is a proof of what has been said. We have seen cases where the cellular membrane contiguous to the brachial and femoral arteries has been completely ulcerated, whilst the coats of the arteries remained sound. We have observed the same phenomenon in the urethra and in the intestines. In cases of suppuration of the prostate gland and cavernous bodies of the urethra, the canal has remained untouched in the midst of a large abscess; and in a case of femoral hernia, where the hernial sac, and the cellular membrane covering it, all mortified, the protruded gut remained quite sound.

The cellular membrane has also a powerful influence in the production of a variety of tumors and excrescences, forming as it were their base or parenchyma of nutrition. Encysted tumors are met with alone in the cellular texture of different parts of the body, and various kinds of solid tumors and excrescences are formed by the growth of that texture on the part where the tumor is to be developed: Afterwards different substances are deposited amongst it, the difference in the nature of which constitutes the difference in the specific characters of these tumors. There is nothing more remarkable in the pathology of the cellular membrane, than the circuitous routes which needles take through it after being swallowed by the mouth.

These remarks will be sufficient to give a general view of the pathology of the cellular membrane, and will enable us to form a more comprehensive and connected view of those diseases, which may be more properly considered as coming within the province of Surgery.

The diseases of the cellular membrane which are treated of in this chapter are, 1. Inflammation of the cellular membrane, or phlegmon. 2. Panaris or whitloe. 3. Sinuses. 4. Carbuncle. 5. Encysted tumors. 6. Steatom. 7. Sarcoma. 8. Œdema. And, 9. Emphysema.

Sect. II. *Of Phlegmon.*

In most accounts which surgical authors have given of *inflammation*, they have taken the description of its general phenomena from inflammation of the cellular membrane.

Local symptoms.

Inflammation of the cellular membrane, or Phlegmon, is characterized by a tumor more or less elevated and circumscribed, visible or not visible, according to the part where it is situated. It is always accompanied with an increased sensibility of the part, with a lancinating or beating pain, a degree of heat greater than natural, a bright redness, which becomes more livid as the disease advances, an elevated point; and it gradually, Of Phlegmon.

ly turns softer from the centre to one part of the circumference.

Constitutional symptoms.

These are the symptoms which are generally to be observed more or less remarkable in every species of phlegmon. When they are slight, and when the affected part is not extensive, or very important from the nature of its functions, this disease generally has not much influence on the general system. But when they are more considerable, and the inflammation extends far, the pulse becomes commonly full, frequent, and hard; at the same time, the patient complains of universal heat, thirst, and other febrile symptoms.

Its terminations.

When by the efforts of nature, or by the application of proper remedies, the pain, the heat, and the tension go away, the other symptoms, which depend in a great degree or altogether on the first which have been mentioned, disappear also, and the patient quickly recovers his health. This termination, which is commonly the most desirable, is called *resolution*.

But if, notwithstanding the remedies used, the different symptoms augment instead of diminishing, the tumor gradually increases in size and turns soft. A small eminence is observed towards the centre of the tumor or at some particular point, and its surface becomes polished. Soon afterwards the pain diminishes, cold shiverings come on, and the febrile symptoms abate; and on compressing the tumor, the fluctuation of a fluid can be perceived in it, this constituting the second termination of a phlegmon, or *abscess*.

Treatment.

Treatment of Phlegmon.—The principal object to be kept in view in the treatment of inflammatory tumors, is to obtain their resolution; this being the most prompt and most certain mode of cure. There are, however, some cases which are an exception to this general rule; such as some inflammatory tumors which precede fevers, and other internal diseases: for it is commonly supposed that in these cases, suppuration is a mode by which nature throws off certain fluids or humours, pernicious to remain in the system. There are other tumors which seem to arise from internal causes, where it is perhaps better neither to attempt to accelerate their suppuration nor resolution, but to trust them entirely to nature. Such are inflammatory tumors in scrofulous subjects. There are few cases of this kind where suppuration ought to be promoted, for their treatment is always embarrassing whether they are opened naturally or by art. It is well known too, that such tumors often remain a long time without any danger; from whence we may conclude, that it is most prudent not to touch them, but attend only to the constitutional treatment.

In the venereal disease, we have a specific for its cure; and when buboes are opened, or other inflammatory venereal swellings, they generally become very difficult and embarrassing to treat. It is therefore always most prudent to attempt their resolution.

The principal means employed to procure the resolution of an inflammatory tumor, are local and general blood-letting, and the application of heat and moisture. Leeches is perhaps the best mode of bleeding the inflamed part; but should the inflammation take place in the extremities, or contiguous to any of the large veins, one of these may be opened. There is no application which tends so much to remove the tension and pain of an inflamed part as the use of poultices or fomentations. Applications of a sedative nature are recommended by many, such as the different preparations of lead, the sulphate of zinc and vinegar; but as far as we have been able to observe, the use of medicines of this class has by no means such powerful effects as emollients, though it has generally been supposed that emollients hasten suppuration. In applying poultices, they should generally be renewed three or four times in twenty-four hours, and the part bathed with hot water each time the poultice is changed. When fomentations are to be used, many employ hot water alone, whilst others prefer a decoction of chamomile flowers, or of poppy heads. A piece of flannel of considerable size, immersed in either of these, of the boiling heat, is to be forcibly wrung out within a cloth, and applied as warm as the patient can suffer it, to the inflamed part. A second piece of flannel is to be prepared in the same manner, and whenever that first applied begins to cool, the second piece is to be employed; and this practice continued for ten or fifteen minutes, and repeated as often as it is found to relieve. The best mode of applying the sedative remedies in external inflammation, is in the form of watery solution. Half an ounce of the acetate of lead dissolved in four ounces of vinegar, with the addition of two pounds of distilled water, is a convenient form. In making use of this solution, it is of consequence to have the parts affected kept constantly moist, and cataplasms prepared with it generally answer that intention exceedingly well. But when the inflamed part is so tender and painful, as not easily to bear the weight of a poultice, pieces of soft linen, moistened with the solution should be employed. Both should be applied cold, or at least of no greater warmth than is merely necessary for preventing pain or uneasiness. They should be kept constantly applied to the part, and renewed before turning dry and stiff.

When the part affected with inflammation is not very tender, or lies deep, applications of vinegar are often had recourse to with considerable advantage; and the most effectual form of using it, is in that of cataplasm, made with the strongest vinegar and crumb of bread. In such cases, the alternate use of this remedy, with the saturnine solution, has produced more beneficial effects than commonly observed from a continued course of either singly.

In all cases of inflammation, the whole body, but more especially the diseased part, should be preserved as free as possible from every kind of motion, and the patient should be confined to a low cooling diet, and also a total abstinence from spirituous and fermented liquors.

In slight cases of inflammation, a due perseverance in the mode of treatment which has now been mentioned will in general be sufficient; but when there is likewise a full, hard, and quick pulse, with other symptoms of fever accompanying the disease, general blood-letting becomes necessary; and the quantity of blood taken away is always to be determined by the extent and violence of the disease, and by the age and strength of the patient. Evacuations, however, should never be carried to a greater extent than is necessary for moderating the febrile symptoms; for should suppuration take place after the system is too much reduced, its progress becomes more slow and uncertain; nor

Of Phlegmon.

nor is the patient able to support the discharge that ensues. Gentle laxatives, with a cooling diet, are also attended with very good effects.

Besides these different evacuations, it is of great consequence to procure the patient ease and quietness. The most effectual remedy for this purpose is *opium*, and, when the pain and irritation are considerable, as in extensive inflammations very frequently happens, it should never be omitted. In all such cases, the opium should be given in full doses, otherwise, instead of proving serviceable, it may not procure rest; a circumstance which is perhaps the chief reason for opiates having been by some very unjustly condemned in every case of inflammation.

Use of opium.

By a proper attention to these different circumstances, a resolution of the tumor will generally begin to take place in the course of three or four days, and sometimes in a shorter time; at least before the end of that period, it may for the most part be known how the disorder is to terminate. If the heat, pain, redness, and other attendant circumstances abate, and especially if the tumor begins to decrease in size, it is probable that, by a continuance of the same plan, a complete resolution will be finally effected.

Suppuration.

But, on the contrary, if all the symptoms rather increase, and especially if the tumor turns larger, and somewhat soft, with an increase of throbbing pain, we may with tolerable certainty conclude that suppuration will take place. We should therefore immediately desist from such applications as were judged proper while a cure was thought practicable by resolution, and endeavour to assist nature as much as possible in the formation of pus, or what is called the *maturation* of the tumor. To effect this, nothing is more useful than fomentations and cataplasms; and if these have not been employed during the former stage, the cold saturnine applications should now be given up, and recourse had to the emollient remedies.

Dry cupping, as it is termed, viz. using the cupping glasses without the scarificator, applied as near as possible to the part affected, is frequently had recourse to in promoting the suppuration of tumors. It is only, however, in those in which there seems to be a deficiency of inflammation, that it can ever be either necessary or useful; but in all tumors of an indolent nature, and where there is still some probability of a suppuration, no remedy is more effectual. By these different applications, continued for a longer or shorter time, according to the size of the tumor, its situation and other circumstances, a complete suppuration may generally be at last expected.

Whilst an abscess is forming, it extends according as the quantity of purulent matter is augmented, and the extension takes place towards that side where there is least resistance. On this account it is that where an abscess is deep, or covered by an aponeurosis, it extends in the interstices of the neighbouring parts, and dissects, as it were, the tendons, the muscles, and the bones, whilst in common cases it makes its way towards the skin. When matter is collected very near the surface of the body, and is only covered by the common integuments, it speedily makes its way externally; but when it is deep, and surrounded by parts which make great resistance, purulent matter insinuates itself until it arrives at some place where there is nothing to oppose its exit; and it is observed making its escape after having made, in some cases, a very great circuit. It is generally towards the inferior parts of the body that purulent matter makes its route. On this account large abscesses open themselves most frequently at their inferior part, and from thence the advantage which is found by waiting till they open of themselves, or that they indicate the place most convenient for the opening to be made. Thus, we see abscesses formed under the temporal muscles discharge themselves in the mouth, and those of the loins making their appearance near the femoral ring, or on the anterior part of the thigh. Deep abscesses, in certain parts of the body, proceed rather towards the interior than towards the surface, because there purulent matter finds less obstruction in its passage. Those, for example, which form on the surface of the lungs, find great resistance from the ribs and other parts forming the thorax, whilst they easily make their way through the spongy substance of the lungs, and open into the ramifications of the bronchiæ. For the same reason, abscesses formed in the cavity of the abdomen sometimes discharge their contents into the stomach or intestines; but as the parietes of the belly yield more easily than those of the chest, we also see abscesses of the different organs contained in the belly, discharge their contents through its parietes.

When matter is fully formed in a tumor, a remission of all the symptoms takes place. The throbbing pain, which before was frequent, now goes off, and the patient complains of a more dull, heavy, and constant uneasiness. The tumor points at some particular part, generally near its middle, where, if the matter be not deep seated, a whitish yellow appearance is observed, instead of the deep red that formerly appeared; and a fluctuation of the fluid underneath is, upon pressure, very evidently perceived. Sometimes, indeed, when the abscess is thick, and covered with muscle and other parts, though from concurring circumstances there can be little doubt of there being a very considerable collection of matter, yet the fluctuation cannot be readily distinguished. It does not, however, often happen that matter is so very deeply lodged as not to be discovered by careful examination. This, indeed, is a circumstance of the greatest consequence in practice, and deserves more attention than is commonly paid to it. In no part of the surgeon's employment is experience in similar cases of greater use than in the present; and however simple it may appear, yet nothing more readily distinguishes a man of extensive observation and nice discrimination than his being able easily to detect deep-seated collections of matter; whilst nothing, on the contrary, so materially affects the character of the surgeon as having, in such cases, given an inaccurate prognosis.

In addition to the several local symptoms of the presence of pus already enumerated, may be mentioned the frequent shiverings to which patients are liable on its first formation. These, however, seldom occur so as to be remarkable, unless the collection is considerable; but it is a symptom almost constantly observed in large abscesses; and when it takes place, along with other symptoms of suppuration, it always contributes to point out the true nature of the disease.

Of opening Abscesses.—When abscesses come to maturity, Of Abscesses.

rity, the integuments gradually become thinner over the more prominent part of the tumor; and ulcerate in one or more points through which pus is evacuated. In many cases it is advisable to wait for the spontaneous rupture of an abscess; but, on the other hand, it is often more prudent, and indeed absolutely necessary, to give vent to the matter by an artificial opening. It is a general rule not to have recourse to such means before suppuration is completely formed; for if an abscess be opened before this period, and a considerable hardness remain around it, the treatment afterwards becomes very embarrassing and difficult. It is, however, necessary in some cases to depart from this general rule, and to open an abscess much sooner; above all, those which are critical, and those which are the consequence of lingering fevers, or where it is a great object to prevent an unseemly cicatrix.

In many cases there is neither safety nor convenience to be expected from the spontaneous opening of the integuments. In abscesses situated on any of the joints, or either of the cavities of the breast or abdomen, and more especially when they seem to lie deep, they should always be opened as soon as the least fluctuation of matter can be discovered; for when the resistance is on either side equal, it just as readily points inwardly towards the cavity, as outwardly towards the skin; and the consequence of a large abscess bursting into either of the large cavities, is most frequently fatal.

Abscesses are sometimes formed about the face, which point externally, and these should be opened in the inside of the mouth, in order to prevent deformity. Whenever the fluctuation is sensible, this should be immediately done. They cicatrise rapidly, and require no dressings.

Abscesses formed under an aponeurosis, and in general under those parts which are not capable of being extended without much difficulty, ought to be opened early. Such are abscesses situated under the temporal muscles, fascia lata of the thigh, in the extremity of the fingers, under the arch of the palate, round the maxillary bones, behind the ear, above the mastoid processes, &c. All these ought to be opened very speedily, and in particular those last mentioned, on account of the danger of a carious bone.

It is also particularly necessary to open without delay abscesses in the neighbourhood of the anus, or near the urethra; in large abscesses of the extremities, and in particular those which are the consequence of violent inflammation, occupying the whole member. If in such cases the matter be allowed to remain too long, the greater part of the cellular membrane is detached from the subjacent aponeurosis, the muscles are separated, and there often follow large gangrenous sloughs, which in separating lay open extensive surfaces, and often form large bags of pus, which become as many separate abscesses. Often the disorder is such that the whole of the integuments of the member sphacelate and fall off. It is also necessary not to delay the opening of abscesses formed among the large muscles, the interstices of which are filled up with cellular texture; such are those about the thigh, the back of the leg, and axilla. In these situations the matter is very apt to spread, and the abscess to form ramifications in various directions, which, if not treated with much care, are very tedious to heal.

With the exception of those cases which have been mentioned, it ought to be observed as a general rule not to open an abscess until suppuration be complete; for if it be true, that pus is always sufficiently prepared to be evacuated, it is so also, that the more we favour its formation before giving it vent, the more we are sure of diminishing and of reducing the hardnesses in the neighbourhood, and facilitating the cicatrization of the ulcer.

Of the different Methods of opening Abscesses.

There are three different modes of opening abscesses; viz. by caustic, by an incision, or by a seton.

1. *By Caustic.*—The use of caustic is recommended in most cases where suppuration has been slow, and has not occupied the whole tumor; in those where the integuments have suffered much, and where it was necessary to wait long before opening it, on account of some affection of the bottom of the abscess; and in general in all cases of suppuration of glands.

But though there are circumstances which may render it necessary to employ the caustic rather than the incision, yet the latter generally deserves the preference. The pain which it occasions is momentary, whilst that from caustic continues many hours; and when the inflamed part has acquired a morbid degree of sensibility, the pain is very violent. The surgeon also can never limit precisely the extent of the action of the caustic; and whatever attention be paid to it, it often extends too far, and penetrates too deep.

To open an abscess with caustic, an adhesive plaster spread on leather is to be applied over the tumor, with a slit or hole in it of a size somewhat less than what is intended to be made in the skin by the caustic. The slit is to be filled with the caustic reduced into powder, mixed with a small quantity of soap, and wetted, so as to make it operate more quickly. Another adhesive plaster is then to be laid over it, and the whole secured with a firm compress and bandage. The time necessary to allow the caustic to make a sufficient opening will depend on the thickness of the skin and strength of the caustic, but generally it requires two, three, or more hours. When the eschar is made, and the matter has not escaped, we ought to assist its exit with the end of a probe, or the point of a bistoury; and the separation of the eschar is to be promoted by emollient applications.

2. *By the Incision.*—Abscesses which are not very extensive, may generally be opened by making a longitudinal incision with the lancet, see Plate DXIII. fig. 1. For this purpose, when the situation of the abscess permits it, the surgeon is to apply one hand on the base of the tumor, and press the pus towards the skin, by doing which there is no risk of wounding any artery, or important part at the bottom of the tumor, and the lancet penetrates into the cavity of the abscess with more certainty and ease, and with less pain. With the other hand an incision of the integuments is to be made in such a direction, that it may terminate at the most depending part of the tumor; and be made of such length as may appear necessary, in order that the matter may be allowed freely to escape. It is in general supposed sufficient, in cases of small abscesses, that the incision extend two-thirds of the length of the tumor. Some authors have advised, that when the integuments are much distended, an incision should be made through the whole length of the tumor, even where

Plate DXIII. fig. 1.

where it is of a large size; but this practice ought to be rarely adopted. The irritation and consequent inflammation, produced from such an operation, must always be very considerable; and as it scarcely ever happens that the integuments are so much extended as entirely to lose their contractile power, there is always reason to hope that they will recover their natural dimensions. In all very large abscesses, it is the safest practice to make at first a small incision sufficient to allow the contents to be completely discharged; for whenever this is done, the extent of the cavity diminishes; and should it be found afterwards necessary to make a more extensive opening, this can now be done with much advantage. When an abscess has been opened by either of these methods, it is reduced to the state of a simple wound or ulcer, and ought to be treated accordingly.

The mode by incision ought to be preferred to that of caustic, when the matter is collected deep; when it is in the neighbourhood of important nerves or blood-vessels; when it is necessary to make the opening large; when the skin which is to be opened has a natural appearance; and, above all, when it is desirable the ulcer be healed rapidly, and leave little deformity.

Although surgeons generally agree in preferring the incision to the caustic, it has nevertheless its inconveniences. Whenever the incision is made, the matter contained in the tumor is suddenly evacuated; hence it happens, when the collection is considerable, that the patient faints, or has some other disagreeable symptoms; but the principal disadvantage of this method is, that it gives free access to the air over a large extent of ulcerated surface; a circumstance which is sometimes followed by very pernicious effects. A total change takes place in the nature of the matter; a laudable pus is transformed into an ichorous indigested fluid; the pulse becomes quick; colliquative sweats and other symptoms of fever come on, and commonly the patient dies in a short time. Surgeons have too often occasion to observe the dangerous effects which are probably altogether produced by the admission of air; for we see a great number of patients have for a long time after a termination of inflammatory diseases considerable abscesses, where the pus is perfectly formed, without shewing at the same time any symptom of hectic fever. But when these abscesses exceed a certain size, and if a large incision be made into them, there always follow symptoms of fever, generally in forty-eight hours from the time that the abscess had been opened. These accidents, which we have frequently observed in private practice, are still more frequent in public hospitals, where the air is impregnated with putrid exhalations.

3. *By the Seton.*—From the observations which have been already made, it appears necessary that as much precaution as possible should be taken to prevent the contact of air with the internal surface of the abscess. The seton, therefore, has the advantage, not only of being attended with little pain, and emptying the abscess in a gradual maner, but it completely prevents the access of the air. When patients are otherwise in good health, there is another advantage in employing the seton; for frequently a cure is obtained at a period much shorter than that which is usually necessary when the incision has been adopted. On the other hand, if we have reason to wish to keep up for a long time a certain degree of irritation and suppuration in the affected part, the seton ought to be preferred to every other means. There have been various instruments contrived for introducing the seton, and it may easily be done by a lancet and common probe, or by the instruments represented in Plate DXIII. fig. 15. and 16. One of these being threaded with glovers soft silk or with cotton, should be introduced into the upper part of the tumor; but if the blunt one be employed, it will be necessary to have the assistance of the lancet. The instrument is then to be brought out at the under part of the tumor, and the matter allowed to run gradually along the threads. The seton should be changed forty-eight hours after it has been introduced, and as much of it should be pulled out at the under part as is sufficient to allow the removal of that which was shut up in the abscess. The abscess is to be dressed in this manner every day as long as circumstances seem to require.

By means of the seton, we obtain a regular and slow discharge of the matter contained in the abscess; the sides of the abscess are allowed to contract in a gradual manner; the presence and friction of the seton on the surfaces excites a slight inflammation, which contributes to unite them, and to complete an adhesion, much more readily than by any other method. In proportion as the discharge diminishes, the thickness of the seton ought to be lessened; and this is easily done by taking out some of the cotton threads every two or three days. It ought to be entirely taken out when no more matter is discharged than what would be produced by the irritation of the seton alone; and by compressing gently the parts for some days after it has been withdrawn, with a compress and bandage, we can in general depend upon a complete cure.

When speaking of the mode of introducing a seton, we recommended that this should be done from above downwards, because, if the first opening be made at the base of the tumor, a great quantity of matter immediately escapes. Thus the boundaries of the abscess at the upper part become effaced, and the passage of the director through the abscess is much more difficult than when the abscess is opened according to the manner pointed out. In that way the under part of the tumor is left completely distended till the last moment, and only a very small quantity of matter escapes by the superior orifice. Another advantage of this mode is, that the part of the seton left for the future dressings, is easily kept clean and dry.

The method of opening abscesses by a seton has been found particularly useful in suppurations of the joints, and those glandular parts where the admission of air is followed by very pernicious effects. Thus, when it is thought necessary to open a scrofulous tumor, we may generally be able to obtain a more prompt and easy cure from the use of a seton, than by making a larger incision. Venereal buboes, too, when come to maturity, have been said to get well much sooner by this than any other method, when the integuments have not become too thin by great distension long continued. On the other hand, this mode is not without its inconveniencies, for in adopting it we cannot be well assured of the state of the bottom of the abscess, which it is often important to know.

Whatever advantages these different methods of opening abscesses may possess over one another, yet there is not one of them which deserves the preference in all cases, although the caustic, as already mentioned, be the means

Of Sinuses. to which we ought most rarely to have recourse. However troublesome it may be, the action of air on the interior surface of the abscess is not always equally pernicious; and when by properly applied dressings, care is taken not to allow purulent matter to form in any particular cavity, and to prevent the access of cold air on the surface of the wound, and above all when the surrounding air, as that in hospitals, is contaminated with putrid exhalations, daily experience shows, that the method by incision is accompanied with most success. On the other hand, we have seen the seton extremely useful in gradually discharging large abscesses, without exciting much inflammation.

These general principles are to be observed in the treatment of abscesses, in whatever part of the body they are found. There are, however, some modifications, some particular details of practice, which ought to be kept in view, when the disease is seated in particular organs, as the eyes, the mammæ, the cavity of the chest, the groin, the scrotum, &c. Mention will be made of these in giving an account of the diseases of particular organs.

Sect. II. *Of Sinuses* (Fistulæ).

When an abscess, instead of healing, continues to discharge purulent matter, and when this takes place through a small orifice, it obtains the name of a *fistula*. The orifice has smooth and callous edges, and the fistula commonly communicates with one or more cavities of different dimensions, situated in the cellular membrane, between the common integuments and the muscles, or between the interstices of the muscles themselves.

These different cavities, which are generally known by the name of *sinuses*, serve as reservoirs, both for the matter which is formed in the cavity of the ulcer, and for that furnished by their own sides. It is thus that when by compression, the matter contained in the sinuses is pressed out through the ulcers, these discharge a much greater quantity than what might have been expected, by alone considering the extent of their surface.

This description of a fistulous ulcer indicates the most simple form of the disease; but when it has lasted for a long time, its whole internal surface frequently becomes hard and callous, acquiring the properties and structure of a *mucous* surface.

The most frequent cause of the formation of sinuses is, when an abscess bursts, and the purulent matter, instead of being all discharged, remains shut up in some part of the cavity. Remaining there, it naturally falls to the lower part, and gradually insinuates itself among the layers of the cellular membrane, which, from its softness, gives little resistance. It advances by degrees among the interstices of the more solid organs, which are connected by that substance; and at last it makes its appearance on the surface of the body, or penetrates into one of the cavities.

Both recent and old fistulous ulcers are generally curable, provided that the ulcer be situated in such a manner, that the necessary remedies can be applied, and the constitution be otherwise free from disorder. But when the disease has been of very long duration, and, above all, when the sinuses open into any articulating cavity, or are placed in such a manner, that one cannot perform any operation, the treatment then becomes extremely difficult, and the event very doubtful. There is no disease which resists more frequently all the efforts of art than certain species of fistula, and particularly some of those about the anus and perinæum.

Of s

Of the treatment of Fistulæ.—There are several different modes which have been proposed for the treatment of this disease, all of which may be useful in particular cases.

By in tion. Injections, supposed to have a cicatrizing quality, have been proposed by some; and these are no doubt useful in particular cases, in diminishing the quantity of the discharge, and preventing the sinus from increasing. When the disease is far advanced, and the edges become perfectly callous, injections of an escharotic quality have been employed; but these remedies have seldom, if ever, produced any good effects; and their too frequent use has even rendered sinuses hard and callous, which otherwise were of a more benign nature.

By co pressio In some cases, particularly when the disease is recent, great advantage may be derived from the proper application of a compress and bandage. In applying these, the compress should be placed in such a manner, and made of such a form, as to make a firm pressure from the bottom of the sinus towards its orifice; and care should be taken that no pressure be made towards the orifice itself, in order that any matter which is formed may not be allowed to collect, but discharged from it. Indeed in whatever mode we treat sinuses, the object to be held in view, is to allow any matter which is formed to be immediately discharged.

By excisi Some have advised, that, in all Fistulæ of long standing, their cavities should be laid open from one end to the other, and all the parts should be dissected out which have become hard, and thus to convert the whole into an ulcer, to be treated in the ordinary manner. There is no doubt, but that by such an operation, it will often be possible to obtain a cure; but independent of the great pain, and of the large and disagreeable cicatrix which must always follow, the practice is not without danger. It cannot answer, for instance, in those fistulas which extend far up the rectum. No practitioner surely would advise the adoption of such a method in the case of fistulas which penetrate very deep, and extend, as often happens, underneath the blood-vessels, the tendons, and the nerves; and even although this practice was without danger, it ought to be adopted in no case, as we are enabled, by an operation more simple, and much less painful, always to obtain a cure with as much certainty as by a total destruction of the parts.

By incision In the treatment of fistulas, it is necessary to procure an agglutination of the edges of the sinuses, so as to obliterate the cavity. The means most efficacious to fulfil this indication are, to make first an opening, so as to allow the exit of the matter; and then to excite a certain degree of inflammation on the internal surface of the cavity, so as to produce an adhesion between its sides.

Both of these indications may, in some cases, be fulfilled in the most convenient manner, by introducing into the orifice of the ulcer a seton which will follow the whole course of the sinus as far as its opposite extremity. The seton should be of a size proportioned to that of the sinus; and it may be diminished by degrees as the cure advances, by taking away some of the threads day after day. At last, when the cavity of the sinus is nearly

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Of Sinuses. nearly filled up, and consequently the discharge much moderated, the seton ought to be withdrawn. Afterwards a bandage is to be firmly applied over the part, which should be allowed to continue a convenient time, in order to obtain a complete cure. In all cases, therefore, we ought to discover the direction of the sinus, which can commonly be done by introducing a probe, or by observing the place in which the matter collects, when it has been allowed time to accumulate, and by marking the place from whence it comes, the pressure is to be made on the affected part. A seton ought then to be introduced into each sinus.

Another means of procuring the obliteration of sinuses is, by a longitudinal incision along the whole cavity. In cases where the fistula extends to parts which it is not dangerous to cut, and where the seton has inconveniences which render it inadmissible, we should not hesitate to have recourse to this means. Indeed, the longitudinal incision of the sinus is to be considered in all cases, as the only means which can be adopted with certainty in the cure of the disease; and though in many cases it may be proper to attempt the cure by the milder means which have been mentioned, yet they often fail, and the mode by incision ought always to be held in view.

We may observe here, that this part of Surgery owes much to the celebrated Mr Pott, he having rendered much more simple and successful the treatment of fistulas, particularly those situated about the perinæum and anus. When a fistula is to be laid open, the first thing to be done, is to determine the extent of the incision. The exact extent of the sinus should then be accurately ascertained with a probe, and it is necessary to lay it open to the extreme point, in order completely to secure the filling up of the cavity. The operation may be performed by introducing a director (fig. 9. and 12.), along the whole course of the sinus, and cutting on it with a common scalpel (fig. 1.); or the sharp-pointed bistoury (fig. 4.) may be introduced along the groove of the director, the point of the instrument pushed through at the bottom of the sinus, and then, by withdrawing the director, the incision may be speedily completed with the bistoury.

Plate DXIII.

New mode of opening sinuses.

A still better method is one we have often adopted in cases of sinus with the greatest advantage. It consists simply in putting a small bit of wax, about the size of a pin head, upon the end of a sharp-pointed bistoury, introducing the point of the instrument thus defended along the sinus; and when it arrives at the bottom of it, the point may be pushed through the skin, displacing the wax with very little pressure. When the point has been brought through the skin, the incision may afterwards be completed with one quick motion of the knife. In laying open sinuses in this manner, it is particularly necessary to form an exact idea of the direction of the sinus, and of the extent of the incision to be made, before attempting to introduce the bistoury. For as a very slight degree of pressure is sufficient to displace the wax on its point, any untoward motion upon the side of the abscess would thus expose the point of the instrument, and render the operation more tedious and difficult, and always more painful.

The principal advantages of this mode of laying open sinuses are, that the operation can be much more speedily performed, and that it costs much less pain to the patient. The introduction of the director through a small fistulous opening, and the tedious process of cutting through the integuments with a scalpel, cannot fail of creating much distress, whereas a thin bistoury can be introduced without giving almost any uneasiness; and after the operator has conducted its point to the bottom of the sinus, it may be pushed through the integuments, and the sinus cut open with a *coup de main*.

Of the Whitloe.

All sinuses should be laid open in this manner, which can previously be detected by a careful examination with the probe; and if the edges of the fistulous sore are found to have acquired a great degree of callosity, it is also sometimes adviseable to cut them entirely away.

The sinuses are now to be dressed by placing between the edges portions of caddis dipped in oil, or simple ointment; and great care should be taken that no portion of newly divided parts be allowed to come into contact, as there will be great risk of an adhesion taking place between them, thus frustrating the very objects of the operation. After the pledgets have been introduced between the edges of the wound, it is commonly directed that the whole wound be covered up with a piece of linen spread with ointment. In place of the ointment, we have generally found a poultice answer better. The poultice, by its moisture, prevents any agglutination of the lips of the wound; and it has the power of diminishing the inflammation more than any other application. The wound is afterwards to be treated on the principle of the common ulcer *.

* See *Ulcers*.

Sect. III. *Of the Whitloe* (Paronychia).

The whitloe is a painful inflammatory swelling, occupying the extremities of the fingers, most frequently at the root of the nails. Several varieties of the disease have been described by authors; and these consist in the structure in which the disease is supposed to have been seated. From what we have been able to observe, it appears to be situated chiefly in the cellular membrane immediately underneath the skin, and in the structure connected with the nails; though at the same time the pathology of this disease is not yet well understood.

The first symptom of the whitloe is an uneasy burning sensation over the point of the finger, or root of the nail. The part becomes tender and painful to the touch; and a slight degree of swelling takes place, resembling œdema, attended by little discoloration. A transparent effusion takes place below the epidermis, and forms a vesication round the root of the nail. A purulent discharge takes place round the edge of the nail, and the nail always separates. The peculiarity in this disease is, that it generally affects several fingers, one after the other, and sometimes all the fingers of both hands.

In the more severe forms of the disease, the inflammation extends to the cellular membrane underneath the skin, and even to the tendinous aponeurosis and periosteum of the fingers, producing caries. In such cases the whole hand generally swells, and the swelling even extends up the arm and affects the axillary glands.

Whitloes sometimes succeed a blow or injury of the finger; but they most usually make their appearance without any known cause.

Treatment.—In the treatment of whitloe, two sets of remedies have been employed. Some use fomentations, poultices, Of the Carbuncle.

poultices, and leeches; whilst others apply ardent spirits, vinegar, cold water, and astringents.

Local bleeding and emollients do not seem to give the same relief in this as in idiopathic inflammation. When, however, the inflammatory symptoms and pain are violent, it is always necessary to take away some blood; and this may be best done at the bend of the arm. The affected part should be afterwards immersed in strong brandy, spirits of wine, or strong vinegar. We have also seen the inflammation much abated by immersing the hand, on its first commencement, in a large vessel of cold water.

It is only, however, in the first stages of this affection that remedies of this kind can prove useful: for, when effusion has actually taken place, and suppuration begun, that state of the disease is produced which these remedies were intended to prevent. Emollient remedies should now be employed; and whenever the presence of a fluid can be ascertained, it should be discharged with a lancet. A free incision into the part affected gives more decided relief than any application or remedy whatever, probably from bleeding profusely, and from relaxing the inflamed membrane or sheath of the tendons.

The wound is afterwards to be treated as a common abscess; but we may remark, that here, more than in any other part of the body, it is of the greatest importance to lay open freely every sinus which the probe can detect. Sinuses, situated here, never heal; and, when allowed to spread, are always attended with mischief. They destroy ligaments and tendons, or at least produce a thickening of the parts around the joints, so as afterwards to interrupt their free motion.

Sect. IV. *Of the Carbuncle.*

The carbuncle (*anthrax*) may be considered as a species of phlegmon, attended with a remarkable degree of malignity, and is one of the symptoms of the plague, where that disease rages, or of typhus fever in this country. It consists in a deep-seated and very hard swelling, attended with an intensely painful sense of burning in the part, and considerable discoloration of the skin.

The carbuncle is often sudden in its appearance. The skin is of a dusky red colour at its centre, but much paler and variegated at its circumference. Vesications appear on its surface, and when these are ruptured they discharge a dark-coloured sanies. The disease sometimes commences with symptoms of general inflammation; but most commonly it is attended with rigors, sickness, great restlessness and depression of strength, fainting, delirium, &c. A miliary eruption, or even petechiæ, are also sometimes found dispersed in different parts of the body.

When suppuration takes place, several openings generally form in the skin; a thin ichorous fluid is discharged, and a dark yellow slough is observed at the bottom of the sore.

Carbuncles most frequently take place about the back, neck, and shoulders, and are generally solitary. They are usually two or three inches in diameter, though sometimes they acquire an enormous size.

The cellular membrane and skin seem to be the principal textures affected in this disease; a great part of the former is always destroyed by the formation and

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separation of very large sloughs, and the latte tensive ulceration.

In the treatment of this disease great attenti cessary, not only to the local applications, but general remedies.

Emollient poultices, and warm anodyne fome ought to be employed during the first stages of ease; and when ulceration of the skin has take the application of an ointment, composed of a c able quantity of the powder of opium, we have relieve very much the pain which the ulcerative generally creates. The use of rags, wet with nitrous acid, or a solution of lunar caustic, ha found of great use in promoting the separation slough, and the granulation of the cavities wh main.

When the constitutional symptoms are inflam at their commencement, it may be necessary to general blood-letting; but the fever being com of a typhoid form, wine, bark, and opium, ough freely administered. It will be also proper to pr a generous diet, and to pay great attention to ke bowels regular.

Sect. V. *Of Encysted Tumors.*

The word *tumor* has been the origin of much sion in the arrangements of diseases adopted by the celebrated nosologists; they have employed it as a to characterise a *class*, and also to express me *symptom* of diseases. A vast variety of diseases thus been included under the class of Tumors, dis which are totally dissimilar, and have no analogy ever. Anasarca, bubo, encysted tumors, scrofulou scirrhous tumors, warts, &c. have all been include der this class, these being as different from one an as any disease with which we are acquainted, ha only one common symptom, that of swelling.

Mr Abernethy has lately made a very laudable tempt to arrange tumors from their structure; like those who preceded him, he has classed dise together, among which no analogy can be discove He divides tumors into sarcomatous, encysted, and seous. Under the sarcoma he includes the stea (adipose sarcoma), medullary sarcoma, and also oth all of which have no resemblance to each other in t history or symptoms.

The word *tumor* ought therefore to be expunged fr nosology, and no longer employed to characteris class of diseases. Its use should be synonymous w that of swelling, and confined to express merely enlargement of any organ of the body, or a n growth; whilst all those diseases, which have be formerly classed among tumors, should be arranged ther according to their specific nature, or to the textu of the body in which they arise. Thus tumors, conne ed with *lues venerea* or *scrofula*, should be included u der these general names. The *steatom*, being a grow of fat, and being always formed in the cellular mem brane, ought to be treated of among the diseases of th texture. Encysted tumors, being also formed in th cellular membrane, ought to be arranged among its di eases; and warts, corns, and other tumors which are di eases of the skin, will with propriety be classed amon them: and the same may be said of all other disease whic which have usually received the general appellation of Tumor. We shall, therefore, in this section, treat of those tumors only which are formed in the cellular membrane.

Under the class of encysted tumors (*tumeurs enkysties, loups, cystides,*) are comprehended all those tumors of preternatural formation, the contents of which are surrounded by a bag or cyst.

Of encysted tumors.

Encysted tumors are generally formed in the cellular membrane, immediately underneath the common integuments. They are moveable, circumscribed, commonly indolent, without heat or any change of colour in the skin; and they are very slow in their formation and progress. They contain a matter more or less thick in consistence; and, according to the nature and consistence of this matter, they are distinguished by different names. They have been denominated *atheroma*, from the contents being of a soft cheesy consistence; *meliceris*, when they contain a matter of the consistence of honey; and *steatoma*, when formed of fat. The steatom, however, ought not to be classed among the encysted tumors, as the thin cellular covering in which it is contained has no analogy in its structure to the *cyst* of the other tumors.

It ought to be observed, that the consistence of the matter contained within the cyst varies in every species of encysted tumor. In the *atheroma* and *meliceris* it has sometimes the firmness of new cheese, and at other times is softer than the most liquid honey. These varieties depend on the length of time which the fluids have remained in the cysts, and in the proportion of coagulable lymph and serum, which have been separated and absorbed, and also on their having been inflamed or not, and on the extent to which this inflammation may have proceeded. Sometimes an encysted tumor is composed of different cysts, each of which contains a substance of a different nature. These different circumstances render in general the diagnosis in the varieties of encysted tumors very difficult; and happily this distinction is not necessary in practice, and perhaps ought also to be omitted in our nosological arrangements. The sac of an encysted tumor is generally pretty firm, and composed of concentric lamellæ. We have observed some of the cysts which were nearly as firm as cartilage, having small chalky concretions formed in many parts between the layers. When the contents of the tumor are washed out, the internal surface of the sac generally appears smooth and polished; but in others, some of the matter adheres firmly to the surface of the sac. In some cases the tumor very much resembles the hydatids found in the liver and other organs; for, besides the firm sac, there is sometimes formed within it, and apparently having no adhesion with it, a thin and very easily torn whitish bag, which contains the fluid.

Encysted tumors are very small at their commencement, and grow by almost insensible degrees. They vary a good deal in their form and size. Those which are formed in the hip, are generally round and smooth; commonly of the size of a nut, and acquire rarely the bulk of a large egg. Those which are seated in other parts of the body are more irregularly formed, and sometimes become of a prodigious size, some having been found which weighed 10, 15, and even 20lbs. They are never painful, at least at their commencement, and the skin covering them, preserves, for a long time, its natural colour; but when they become very large, the veins of the skin become varicose; and the skin on their upper part becomes polished, and acquires a reddish colour, similar to that of a part inflamed. Tumors of this kind seldom give pain or uneasiness, except when they receive a blow. Inflammation and pain then readily come on, and the cyst ruptures if not previously opened by an instrument.

Such is the usual progress of encysted tumors; and although they do not come to a rapid termination, yet this sometimes happens more readily under certain circumstances, and even before they have acquired a large size. In the hip, for example, we perceive the integuments become tender and very thin, and open before the tumor has acquired any considerable size. But on other parts of the body, and particularly the back, shoulders, and thighs, the integuments preserve their natural appearance, even when the tumor has acquired a large bulk. This appears to arise from the skin being more loose in these parts.

The situation of encysted tumors also contributes much to determine the degree of adhesion which they have contracted with the neighbouring parts. In some situations they are so detached, especially while they continue small, that they readily alter their situation by very slight degrees of pressure; but in others, particularly when covered by any muscular fibre, they are more firmly fixed from their commencement. The attachment of encysted tumors is also influenced by their remaining more or less free from inflammation; for they never become inflamed, even in the slightest manner, without some degree of adhesion being produced between the cysts and contiguous parts.

Mode of their formation.

It has generally been supposed that the membrane which forms the cyst of this species of tumor is not a new formation, but produced by a collection of fluid in one of the cells of the cellular membrane, which by its increase dilates the cell, and brings it in close contact with the adjacent cells, so as finally to obliterate them, and increase the thickness of its own coats.

The ingenious Bichât* has shown that this opinion so generally adopted is without foundation, and that the formation of encysted tumors more probably depends on laws, analogous to those which regulate the growth of the different parts of our bodies. He has also shown that there is a great analogy between these cysts and the *serous* membranes. The cysts, like serous membranes, form a species of sac without an opening; they contain the fluid which they exhale, and they have a smooth and polished surface contiguous to the fluid, whilst the other surface is unequal, and connected with the adjacent cellular membrane. The cysts have a similar structure to serous membranes; maceration, &c. proving them both to be composed of a cellular texture. In the natural state neither of them have any sensibility, but when inflamed they both become extremely sensible. The cysts also are evidently secretory organs, exhaling the fluid with which they are filled, and their power of absorption is also very manifest from the spontaneous cures of some encysted dropsies.

* Vide *Anatomie Generale.*

These considerations led Bichât to conclude that there exists a perfect resemblance between the cysts of

encysted

Of Encysted Tumors.

encysted tumors and serous membranes. An important question here presents itself, to know how these cysts are formed, how a membrane which did not exist in the natural state can be produced, and can grow under certain circumstances? The mechanical explanation of these phenomena which has already been mentioned, though at first sight it may appear simple and satisfactory, yet is by no means conformable to the usual proceedings of nature. How does it happen that as the cysts and serous membranes are analogous, these membranes are formed in a different manner, the serous membranes never being formed from a compression of the cellular membrane? How is it, if the cells are applied and compacted with one another so as to form a sac, that the neighbouring cellular membrane does not disappear, or even diminish, whilst the sac acquires a large bulk? These reflections would lead us to believe with Bichât, that the common manner of explaining the formation of cysts is essentially different from the manner which nature generally follows in all her operations.

Bichât ingeniously remarks that all tumors which vegetate externally, or appear internally, are formed and grow in the same manner as the cysts, there being no difference between these two morbid productions but the form in which each of them appears. Most tumors throw out upon their external surface the fluid which they separate. The cyst, on the contrary, exhales that fluid from its internal surface, and preserves it in its cavity. "Suppose a fungous tumor in suppuration (says Bichât), transformed in a moment into a cavity, and the suppuration to be transported from the external surface to the sides of the cavity, that cavity will then become a cyst.—Reciprocally, suppose a superficial cyst, the cavity of which is obliterated, and of which the fluid is exhaled from its external surface, you will then have a tumor in suppuration.

"If therefore the form alone establishes the difference between tumors and cysts, how does it happen that the formation of the latter is not analogous to that of the first? or has ever any one attempted to attribute the formation of external or internal tumors to compression? We ought therefore to conceive the production of cysts in the following manner: they begin to be formed in the cellular membrane by laws analogous to those which regulate the general growth of our bodies, and which appear to be deviations of these fundamental laws of which we are ignorant. When the cyst is once formed, exhalation begins to take place, and though at first in a small degree, it at last augments in proportion to its progress. The increase of the exhalent organ then always precedes the accumulation of the exhaled fluid, in such a manner that the quantity of the suppuration of a tumor is always directly in proportion to its bulk *."

* *Anatomie Generale.*

This mode of explaining the formation of cysts appears much more conformable to the laws of nature than that which has been formerly mentioned and generally received. But it still remains to determine the precise mechanism of the origin and growth of cysts, and consequently of all other tumors. We ought to stop where the first causes commence; and as we do not know the mechanism of the natural growth of our organs, how ought we to guess at that of morbid productions which depend upon the same laws. It is a great deal in the economy of our organs to poin out analogies, and to show the uniformity of a phenomenon not understood with one in regard to which all the world agree. Much would be done for the benefit of science, if in all its branches we could demonstrate that principle on which depends such a great number of effects, that nature, avaricious in her means, is prodigal in her results; that a few causes preside over a multitude of effects, and that the greater number of those regarding which we are uncertain, depend on the same principles as many others which appear to us evident.

Of the treatment of Encysted Tumors.—Encysted tumors, though not dangerous, are often inconvenient from their size, situation, and the deformity which they produce, so that whenever their removal becomes necessary, this can only be done by a surgical operation.

By the seton.

If the tumor be of the *meliceris* kind, which for the most part will be the case when a distinct fluctuation is perceived in it, it ought to be treated as a common abscess. If the tumor be small, the matter may be discharged by puncturing the most dependent part with a common lancet, and treating it in the ordinary way till the sides of the cavity come in contact by adhesion, or by the process of granulation. But when the tumor is more considerable, the free admission of air into the interior of its cavity is always dangerous; and we ought to be attentive to prevent its effects by making the opening in such manner, that the wound be exposed as little as possible. When treating of abscesses, we have recommended the passing of a seton or cord through them, as the best method of opening them when they are of a large size. This method is also very convenient in those encysted tumors, which contain matter of a liquid consistence. It will only be necessary here to observe, that the seton should traverse the whole tumor, from the superior part of it to the most dependent point, and that the inferior opening should be sufficiently large for allowing the matter to be freely discharged. This method often answers extremely well; and cures have by it been performed which could not have been obtained in so short a time in following the ordinary method of treatment by incision. But this method cannot be employed, except in those cases in which the contents of the tumor are so liquid as to be easily discharged by a small opening. When it is of too firm a consistence to admit of the seton, the contents must be emptied, either by making an extensive opening into the cyst, or by dissecting out the cyst and its contents.

When an encysted tumor adheres so firmly to the contiguous parts, as to render its removal tedious and difficult, it is often better not to undertake the operation. In such a case it will be sufficient to lay open the tumor its whole length, and to cut away any portions of the cyst which can easily be detached. The contents of the tumor will in this manner be completely removed, and the cure will be effected, either by keeping the wound open till the cavity of the cyst is filled with granulations; or it may be attempted by drawing the divided edges of the skin together, and applying moderate pressure, so as to produce adhesion with the sides of the cavity. It sometimes happens, however, that from the adhesion being complete, the remaining portion

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tion of the cyst forms as it were the nucleus of a new tumor.

Operation.—When it is determined upon to remove the cyst completely, the first step of the operation is to make a free incision, with a common scalpel, through the integuments covering the tumor*. If the tumor is not very large, a longitudinal incision will answer the purpose; but should the tumor be of such a size, that the whole integuments covering it are too large to lie neatly upon the wound, it is much better to remove an oval portion of skin†. The size of this portion must be left entirely to the judgment of the operator, who should always take care that a sufficient quantity is left, completely to cover the wound. After the skin is divided, the cellular membrane should be dissected back, so as distinctly to expose the surface of the sac; and as the sac will be generally found loosely attached to the adjacent parts, it may be easily separated by a very simple dissection. In removing encysted tumors, it is particularly necessary to cut fairly down upon the sac; for if this be not done, instead of the tumor being readily turned out of the sheath of loose cellular membrane which surrounds it, it can only be removed by a very tedious process of dissection. Some surgeons have recommended that the contents of the tumor should be removed, before attempting to dissect out the sac; but if the incision of the integuments be made sufficiently large, this may generally be avoided. We have often observed the operation of extirpating encysted tumors, and indeed tumors of every description, rendered extremely tedious by a want of proper attention to this step of the operation. We would therefore particularly recommend, that, in the extirpation of all tumors, the incision of the integuments extend both above and below the tumor a considerable way, proportioned in all cases to its bulk and easy access.

* See Plate DXIII. fig. 1.

† See *the tumor represented in* Plate DXIII. fig. 19.

In some cases it is adviseable to open the cyst, and remove its contents, before an attempt be made to dissect it out. This practice will only be necessary in cases where, either from the shape or situation of the tumor, it is impracticable to pass the knife round it, and where, from the situation of important parts at its base, the dissection is rendered very nice and delicate. In a case of encysted tumor closely attached to the capsule of the knee joint, great advantage was derived from operating in this manner. Whilst the tumor remained distended, it was impossible to separate it, without great risk of cutting, either into it, or into the cavity of the knee joint. When, however, its contents were removed, the membranes could be readily dissected from one another, without the smallest risk of injury.

After an encysted tumor is extirpated, if any artery bleed very profusely, it ought to be secured by a ligature; but this should always be avoided as much as possible, as ligatures are apt to interfere with the adhesion of the lips of the wound. At the same time it is always necessary that the bleeding be completely stopped before the wound is dressed; for should any hemorrhagy take place after the dressings have been applied, it is very apt to displace the edges of the wound, and prevent them from adhering.

The edges of the wound are to be placed accurately together, and kept in contact with adhesive plaster, a compress and proper bandage being applied over it. In some cases the twisted suture is advantageous. The wound is to be treated in the usual manner, removing the dressings whenever they become soiled, and the application of the adhesive plaster continued till a complete cicatrization has taken place.

Sect. VI. *Of the Steatom* or *Fatty Tumor* (B).

Tumors of this species consist of a mere accumulation of cellular membrane and fat in a particular part of the body. They occur frequently, and are formed most commonly on the front or back part of the trunk of the body, and sometimes on the extremities. They generally grow in a slow and progressive manner, and the blood-vessels are neither large nor numerous. They have always a thin capsule of common cellular substance; and this capsule seems merely to be the effect of that condensation of the surrounding cellular membrane which the pressure of the tumor occasions. "As the growth of adipose tumors is regularly and slowly progressive, and as nothing like inflammation in general accompanies their increase, their capsules afford a striking instance of an investment acquired, simply by a slight condensation of the surrounding cellular structure, unaffected by inflammation*." When the capsule, which is extremely thin, and which adheres but slightly to the tumor, is removed, the tumor within consists of a mere piece of fat, more or less compacted according to its situation in the body, and the length of time which it has remained.

* *Abernethy's Surgical Observations*, p. 27.

Of the treatment of the Steatom.—When a steatom is small, when it causes little deformity, and does not seem to injure the functions of any organ, it is most prudent to allow it to remain. Sometimes they acquire a very large bulk, and from their situation are extremely inconvenient and unseemly; and they then become an object of medical treatment. No external application has ever been known useful in discussing tumors of this kind; and the only means to be employed for removing them is by an operation. There is indeed no species of tumor that can be dissected out with so much celerity, or with such apparent dexterity. In some cases, however, if inflammation has been induced, the capsules even of these tumors are thickened, and adhere so as not to be separated without difficulty.

In dissecting out a tumor of this kind, the same general rules may be followed as have been mentioned when treating of encysted tumors. The external incision should be made very free, and it is also of great importance to cut completely down to the capsule of the tumor, before attempting to dissect it out.

Sect. VII. *Of the Sarcoma* or *Fleshy Tumor*.

Our knowledge of the pathology of tumors of the cellular membrane is yet too limited to be able to arrange them in any systematic form; and it would be foreign to our purpose to attempt the investigation of

(B) Steatoma, *adipose sarcoma* of Mr Abernethy.

Sarcomatous Tumors.

of the subject. We have adopted the term *sarcoma* as very general; and include under it all those swellings or wens of a fleshy feel, which occur in the cellular membrane throughout the body.

The basis of these tumors, as we before mentioned, is the cellular membrane; and the difference in the qualities of the substances deposited in the cells gives the peculiar appearance to the tumor.

The vessels which pervade such tumors are either larger or smaller, and more or less numerous. They are also distributed in their usual arborescent manner, without any apparent peculiarity of arrangement.

When tumors of this kind have attained a considerable size, the superficial veins become very large. They have little sensibility, enduring a rough examination.

This kind of tumor generally grows till the skin is so distended as to ulcerate, and expose the new formed substance, which sometimes sloughs away. In this manner does the disease occasionally terminate; but such is the constitutional irritation attending this process, and the disgusting fœtor and frightful appearance of the part, that the surgeon generally recommends its removal. In some instances sarcomatous tumors are composed of a number of irregular-shaped masses, which from their resemblance to the pancreas have been called by Mr Abernethy *pancreatic sarcoma*, and considered as a distinct species. "This new-formed substance is made up of irregularly-shaped masses, which in colour, texture, and size, resemble the larger masses composing the pancreas. They appear also to be connected to each other like the portion of that gland, by a fibrous substance of a looser texture." Other sarcomatous tumors are composed of a number of cysts, containing sometimes a transparent and sometimes a dark fluid; and have been called by Mr Abernethy, the *cystic sarcomas*.

The *Mammary* and *Tuberculated Sarcomas* are other two species enumerated by Mr Abernethy. In the first the structure of the tumor has been supposed to resemble the natural structure of the mamma, and in the second the tumor "consists of an aggregation of small, firm, roundish tumors of different sizes and colours, connected together by a kind of cellular texture. The size of the tubercle is from that of a pea to that of a horse-bean, or sometimes larger; the colour of a brownish red, and some are of a yellow tint (c)."

These different terms employed to characterize the various kinds of swellings which form in the cellular membrane, are by no means adequate; and tumors will be daily met with which it is impossible to assign to one or other of these species. This subject therefore still remains open for the investigation of future inquirers. And it is probable, that when the subject is better understood, the surgeon will not on all occasions be obliged to have recourse to the knife; but that he will be able to distinguish those which may be allowed to remain as harmless, from those whose nature is more malignant, and require an early extirpation.

Sarcomatous Tumors.

Treatment.—When sarcomatous tumors are painful and tender to the touch, advantage may be had by local blood-letting, either by leeches or cupping. Fomenting the parts with a decoction of chamomile flowers or poppy heads, and applying a solution of muriate of ammonia or of vinegar with acetate of lead, are useful in diminishing their bulk. Frictions with unctuous substances, as mercurial ointment and camphor; camphorated spirits, aqua ammonia and oil; tincture of cantharides, have all been used for the discussion of indolent swellings: Soap and mercurial plasters have also been much commended; but of all these remedies perhaps there is none more useful than friction with the dry hand. The mode by which this practice is to be conducted is particularly mentioned under *Swellings of the Joints*. While these applications are made to the tumor, we ought also to give purgative medicines every second or third day, and enjoin an abstemious diet, with rest. An alterative course of medicine is also supposed to be useful. Small doses of calomel or corrosive sublimate are given for this purpose. The extract of hyoscyamus and calomel, or calomel and the extract of cicuta, has been much extolled by some.

By caustic.—Some surgeons (and it is a favourite practice with all itinerants) have attempted to remove tumors with caustic; and though this mode is much more painful and more clumsy than the knife, yet there are some cases, where, either from the situation of the tumor, or from the patient being timorous, this practice may be resorted to.

When a tumor is to be removed by caustics, the common caustic potass will answer the purpose extremely well. This is to be placed over a sufficient bulk of the skin, and allowed to remain longer or shorter according to the depth of the tumor, and the portion of it intended to be removed. After the dead portion has separated by the assistance of poultices, &c. the caustic may be again renewed until the whole mass is thus destroyed. Equal parts of red precipitate and burnt alum form a very active caustic; but it creates great pain. By mixing opium with the caustics, the pain is alleviated.

By incision.—When a sarcomatous tumor is to be removed by incision, the surgeon should always keep in remembrance, that whilst the tumor is growing, the contiguous cellular membrane is generally condensed, and is thus formed into a kind of capsule. A knowledge of this circumstance not only renders the extirpation of the tumor much easier, but tumors may be cut out from a depth, and from connexions, apparently dangerous. The integuments are to be freely divided, and the incision carried down to the capsule of the tumor, before attempting to dissect it from the contiguous parts. If this be not done, the dissection becomes more tedious and difficult, and more blood is lost than was necessary, from vessels being divided which might have been saved; and if the tumor happen to be deeply seated, its extirpation becomes thus impracticable. The general directions given for the extirpation and after treatment of encysted tumors may also be applied to the sarcomatous tumors.

Sect.

(c) Another species of sarcoma has been termed the *osteo-sarcoma*, from bony matter being formed in the tumor.

Oedema.

Sect. VIII. *Of Oedema.*

Oedema consists in the effusion of a watery fluid in the cellular membrane of any part of the body.

The swelling in œdema is not circumscribed. The skin of the swollen part retains its natural colour, and sometimes becomes paler than natural, having a glossy hue. The part has a cold feeling; and pressure made by the point of the finger forms an impression or dimple, which remains for some time after the finger is removed, disappearing slowly. There is no acute pain, but there is an uneasiness or sense of weight and tightness in the part. If a limb be œdematous, the magnitude of the swelling is always increased or diminished, according as it is placed in a depending or horizontal posture. Oedema always arises from the want of proper balance in the functions of the exhalent and absorbent systems, and it appears both in a constitutional and local form. Contusions, sprains, the long use of relaxing poultices and washes, are often local causes of œdema. More or less œdema is conjoined with erysipelatous inflammation. A part which has been acutely inflamed often remains œdematous for some time afterwards. It is also often owing to some impediment to the return of blood to the heart. Pressure of the gravid uterus on the iliac veins often renders the lower extremities œdematous. Aneurisms and other tumors, by compressing the veins of the extremity, often produce this affection. It also accompanies *ascites*, *hydrothorax*, &c. &c.

Treatment.—As an œdematous swelling is generally the effect of some other disease, the cure must depend upon the original disease being removed.

If the limb be the part affected, it should be kept in a horizontal position. Frictions made with flannel, and a moderately tight roller, applied from the toes upwards, have a powerful effect in diminishing the swelling. The operation of these means is to be assisted by purgatives and diaphoretics. See MEDICINE.

If the tumor become so tense as to create much pain and inflammation of the skin, these may be moderated by the discharge of the fluid by means of a small puncture, rather than by allowing the integuments to burst. A puncture is, however, not void of danger, for wounds in dropsical constitutions, generally excite a great degree of inflammation, and are apt to become gangrenous. The puncture should be made upon the most prominent parts of the swelling with the point of a lancet; and as the fluid which oozes out is apt to create great irritation of the tender skin over which it flows, it is a proper and very useful precaution to keep the skin always covered with some unctuous adhesive substance. For this purpose the *unguentum resinosum* is very well calculated.

Sect. IX. *Of Emphysema.*

Emphysema is an effusion of air into the cellular membrane of any part of the body.

The swelling is without pain, and colourless; and it is easily distinguished from œdema by the noise and particular feeling it has when pressed upon. It makes a crackling noise, and resembles the feeling created by pressing a dry thin bladder half filled with air. The swelling is not heavy. At its commencement, it only affects one part; but it soon spreads over the body, and distends the whole skin. In one case it was limited to one-half of the body.

Oedema.

Emphysema generally arises from a wound of the lungs; often from a spicula of a broken rib *. It has also been known to arise from an ulceration in the lungs; but this seldom happens, as the inflammation attending the formation of matter condenses the contiguous vesicles, and produces adhesions between the lungs and cavity of the thorax.

* See *Wounds of the Thorax.*

Emphysema has also been sometimes observed in some putrid diseases. Dr Huxham has recorded a case of this kind in a sailor who was attacked with putrid fever and sore throat †.

A partial emphysema has also been observed in cases of gangrene. Dr William Hunter has mentioned a case of that kind.

† *Medical Observations and Inquiries*, vol. i.

The treatment of emphysema must always depend on the nature of the original disease. It may be here, however, remarked, that effused air is readily absorbed, and creates no inflammation or any change in the cellular structure where it had been effused.

Chap. II.

Of the Diseases of the Skin.

General Remarks on the Pathology of the Skin.

There are a considerable number of diseases which originate in the different parts composing the skin; and there are others which seem to be the effect of that sympathy which the skin has with most organs of the body.

Of the diseases which attack the skin, there are five classes. In the first, the papillæ are affected; in the second, the cellular membrane contained in the areolæ of the skin; in the third, the rete mucosum or capillary net-work, from which the exhalents arise; in the fourth, the cutis vera or chorion; and in the fifth, the epidermis or scarf skin.

1. Under the diseases of the first class, or those of the papillæ, may be considered all those in which an alteration in the sensibility of the skin takes place. Whenever inflammation affects the skin, this alteration of sensibility is perceptible; and in some of the nervous diseases of women it is very remarkable; for on touching the skin a little roughly, convulsions are produced. The effect of titillation is well known; and perhaps an application of this knowledge might be extremely useful in the treatment of some diseases.

2. We have examples of the second class of diseases of the skin, where the areolæ of the cellular membrane of the cutis vera become inflamed, in boils and perhaps also in smallpox, and in some of those tumors commonly called pimples of the skin.

3. The rete mucosum, from its vascularity, is probably the seat of erysipelas, measles, scarlatina, and that multiplicity of eruptions to which the skin is subject.

4. In elephantiasis, cancer, warts, &c. and in general in all chronic cutaneous diseases, the cutis vera is affected; it appears, however, to be seldom primarily affected in acute diseases.

5. The epidermis is passive in all the diseases of the skin, and is only affected by its continuity. Its sensibi-

lity is never increased, nor is it susceptible of being inflamed, and consequently it never forms adhesions. Its internal surface, too, raised by a blister or any other means, and applied to the parts below, never reunites. The excrescences which form on it, such as corns, &c. are dry and inert, and without circulation; if they are painful, it arises alone from their pressure on the nerves of the subjacent parts.

From all these different affections of the skin, a number of sympathetic affections arise which it is worth while here to remark, though only a few of the diseases of this organ come properly within the limits of a system of surgery.

1. Every time that the papillæ are much excited in irritable people, as by titillation, various organs are sympathetically affected. Sometimes it is the heart; hence follows fainting. Sometimes the stomach, and in two cases mentioned by Bichât, the person vomited. In one case it excited violent coughing. Sometimes it is the brain, as is observed in people, where tickling brings on laughter, and even violent convulsions.

"Medical men," says Bichât *, "are often astonished at the extraordinary effects which quacks produce on the body from the knowledge they have acquired of the sympathies of the skin produced by titillation. But how should we be more astonished at this, than by vomiting produced by diseases of the womb, by diseases of the liver being brought on from an injury of the brain, or by headaches arising from a disordered state of the gastric viscera?" The influence of titillation of the skin may be of much use in the treatment of some diseases. In hemiplegia, &c. would not the excitement of the soles of the feet, which have so much sensibility, as every one knows, answer much better repeated ten or twelve times a day, than the application of a blister, the irritation of which continues only during a short time? †

From this sympathy which the skin has with distant organs, we may perhaps be able to explain the influence which friction has been lately found to have in some diseases. This remedy has been employed to a very great extent in diseases of the joints, and the best effects experienced from it ‡.

2. Whenever the exhalents of the skin, or the exterior capillary system from whence they arise, are affected in any manner, a number of other parts participate, and thence arises a second order of sympathies of the skin.

There are few organs which have more sympathy with the skin than the stomach. The bath, which acts upon the skin, during digestion affects sympathetically the stomach, and disturbs its functions. When that organ is spasmodically affected, it often is restored to a state of health, by the influence it receives from the bath. Bichât mentions a case of a woman who was troubled with constant vomiting, in consequence of suppressed menses; and who was immediately relieved by the warm bath after other remedies had failed.

The action of cold on the skin produces a variety of sympathetic effects; above all when that action takes place during perspiration. It is also well known what a number of phenomena result from a sudden disappearance of some eruptions of the skin.

3. When the cellular membrane contained in the areolæ of the skin, becomes inflamed, as in boils, pustules, &c. a number of sympathies ensue, which may be referred to the cellular system in general.

4. The diseases of the cutis vera and epidermis being all of a chronic nature, their sympathetic affections have the same character, little more being known of them.

Besides diseases of the skin, originating from a change of structure in that organ, there are others which arise from the sympathy it has with other organs. Whenever a cold body enters the stomach whilst there is a perspiration on the skin, the perspiration instantly stops. The entry of warm drinks into the stomach, and an augmentation of the cutaneous exhalation, are two phenomena which coincide at the same moment, in such a manner, that one cannot attribute the second to the absorption of the drink, to its passage to the venous blood through the lungs, and then to the arteries. The production of perspiration is, therefore, analogous to the suppression of it in the former instance. Hence will be found a great variety of phenomena in different diseases, arising from the sympathy existing between the skin and the other organs, various degrees of dryness, of moisture, and of perspiration. Sometimes these phenomena are chronic. In many organic diseases, different kinds of tumors are formed on the skin, in the same manner as we observe petechiæ, miliary eruptions, &c. &c. produced in acute fevers; the difference being merely in the duration of the periods of the sympathetic affections.

The diseases of the skin form a very important class in a system of nosology. There are, however, only a few which ought properly to be considered in a system of surgery.

The skin is the seat of all eruptions, as smallpox, measles, and a vast number of other diseases. It is liable to inflammation, suppuration, and gangrene. It is also subject to diseases and injuries from its exposure to the action of external bodies, and from serving as a defence to the internal parts. It is also subject to cancer, warts, and other excrescences, the treatment of which more properly belong to the surgeon.

Sect. I. *Of the Erysipelas*, or *Rose*.

Erysipelas is sometimes a local disease; at other times it is merely a symptom of some other affection. It differs from all other inflammations in its peculiar shade of red colour, and it is also remarkable for the disturbance which it generally creates throughout the whole system. The part of the skin which is affected becomes of a bright scarlet colour, with a tinge of yellow; and towards the termination of the complaint, the yellow becomes more discernible. Besides the difference in the shade of red, the swelling is neither so hard, so elevated, nor so circumscribed as that of phlegmon. The skin has a glossy smooth appearance, a burning heat, and on its being touched with the finger, the scarlet colour disappears, leaving a white spot, which, however, is almost immediately replaced when the finger is removed. The pain attending the disease is sometimes very great; there is also more or less swelling of the parts in the immediate vicinity; and this seems chiefly to arise from a watery effusion in the cellular membrane.

Erysipelas is very apt to spread rapidly to a great extent;

* Bichât *Anatomie Generale*, tom. iv. p. 730.

† See a case where this practice was successfully employed, in the *Edin. Med. and Surg. Journal*, vol. iii.

‡ *Treatment of the White Swelling of the Joints.*

Erysipelas.

extent; and it frequently changes its situation, growing gradually well on one side, and extending itself on the other. Sometimes it disappears entirely at one place, and attacks some other. As this disease gets well, the cuticle peels off from the affected part.

Erysipelas may be combined with phlegmon (erysipelas phlegmonoides), in which case the inflammation is of a deeper red colour; the swelling is also greater and deeper, and the pain is more acute. There is also a throbbing in the part, and the pulse is full and hard.

There is also a particular species of erysipelas, called *St Anthony's fire*, in which small vesicles are formed on different parts of the skin. These burst, and discharge a thin fluid which forms a scab, and beneath the scab suppuration sometimes takes place.

The true erysipelatous inflammation seldom suppurates, but generally terminates by resolution; very violent cases sometimes cause gangrene.

When Erysipelas is accompanied with inflammation of the cellular membrane, as there are no distinct limits of the disease, the matter which is formed in those cases which advance to suppuration, often extends very far in every direction, and sometimes produces very considerable sloughing, not only of the cellular substance, but of the fasciæ and tendons. Erysipelas is generally accompanied with all the symptoms of general fever, and these occur in a very considerable degree, even where the external inflammation is extremely slight. Languor, lassitude, weariness in the limbs, headach, loss of appetite, oppression about the stomach, precede the appearance of the local complaint. The most violent form of erysipelas is most frequently seen in the face, producing a great deal of general fever, often accompanied with delirium; and in a few cases we have known it to proceed so far as to inflame and suppurate the membranes of the brain. Erysipelas seems to be intimately connected with the state of the general constitution. Persons in the habit of drunkenness and other species of intemperance, and who, when in a state of intoxication meet with local injuries, often have erysipelatous inflammation. In general, erysipelas has its principal source in a disordered state of the chylopoetic viscera, more particularly the biliary secretion. It seems also to be often connected with a suppression of perspiration, for it never recedes until that symptom is relieved.

Of the treatment of Erysipelas.—The mild erysipelas is to be relieved by the exhibition of gentle diaphoretics. A few doses of nitre, in order to promote the ordinary evacuations, and general attention to the antiphlogistic regimen.

It is also of great importance to attend to the state of the bowels, and to give purgative medicines, both with a view of removing any feculent matter contained in them, and as a general evacuant.

When the case is conjoined with phlegmon, and when there are symptoms of inflammatory fever, venesection becomes necessary; and this is particularly the case when the face is the seat of the disease.

When the patient has a very foul tongue, a bitter taste in his mouth, and a propensity to vomit, purgatives and emetics become necessary. Indeed, in almost all severe cases, an emetic is indicated, and ought even to be repeated, should the symptoms continue.

There has been a great variety of opinions with regard to the external treatment of erysipelas; some recommending the part to be kept dry, of a moderate warmth, and excluded from the air: others have used warm or cold moist applications. The practice of Dessault is perhaps the most judicious. In those cases of erysipelas produced from an internal cause, no topical application is to be employed, except, perhaps, dusting the part with flour; but when any species of erysipelas succeeds a contusion, a wound or an ulcer, the regimen and internal medicines are insufficient, if proper topical remedies are not at the same time employed to alleviate the local irritation. In these cases Dessault employed poultices, the good effects of which were confirmed by numerous observations. He considered it, however, as an essential precaution, not to extend this topical application further than the bruised part, or the edge of the wound or ulcer. If any application is made to the erysipelatous surface, it ought to consist merely of a weak astringent solution: that which was always employed at the Hotel Dieu, consisted of a scruple of the extract of lead in a pint of water.

Sect. II. *Of the Furunculus* or *Boil.*

The furunculus appears to be an inflammation of the cellular membrane of the areola of the chorion; the other inflammations of the skin and cutaneous eruptions being seated on the *corpus reticulare*. The furunculus is a circumscribed, very prominent, and hard tumor, of a deep red colour; and they vary, from the size of a pea to that of a pigeon's egg. They are extremely painful, and are seldom attended with much fever. They are most frequent in young people. Boils generally pass into a more or less perfect suppuration. A small white spot is formed on the apex of the tumor, which, when it has reached the skin, discharges but a small quantity of pus in proportion to the bulk of the swelling. Before the tumor begins to subside, a yellow slough, formed by a portion of dead cellular membrane, comes away.

As swellings of this kind almost always suppurate, and as induration constantly remains after an incomplete resolution of them, we ought to promote suppuration by using emollient applications. Emollient poultices are best for this purpose. When a quantity of matter is collected, it is sometimes more advantageous to open the boil with the point of a lancet, than to allow it to remain until the skin ulcerates. Aperients and the antiphlogistic regimen ought not to be omitted.

Sect. III. *Of the Chilblain.*

The chilblain is a painful, and very often an extremely itchy swelling of the skin of an extreme part of the body, in consequence of exposure to extreme cold, or sudden change from a very cold to a warm atmosphere.

Chilblains are most frequently in young people of scrofulous constitutions, and in this country the disease is most prevalent during the winter months. It appears most

Chilblain. most commonly on the toes, heels, and fingers, and sometimes on the nose and parts where the circulation is most languid.

The first symptoms of the disease are a paleness of the part, which is quickly succeeded by more or less redness, a very troublesome itching, and sometimes pain. The skin gradually acquires a purple hue; the part swells, and the cuticle separates from a serous effusion below it. Beneath the cuticle an ulcer appears of a very irritable character, and accompanied with great pain. This ulcer spreads rapidly, has very acute edges, and its surface is of a dark or rather dirty yellow colour. Sometimes the ulceration penetrates as low as the tendons, or even exposes the surface of the bones, producing sphacelation of an extremity.

In the treatment of Chilblains, before the skin has ulcerated, the principal attention ought to be paid to keeping the affected part of an equal temperature, and rubbing it over with stimulating applications. Camphorated spirit, spirit of turpentine, &c. have been generally recommended for this purpose; but the tincture of cantharides, properly diluted, is much more efficacious. A drachm of this tincture to an ounce of the soap liniment, will generally be found to answer extremely well; and this is to be well rubbed on the part once or twice a day.

When vesications begin to appear, and ulceration has taken place, emollient poultices should be employed; but after this process has gone on a certain time, and the pain and irritation abated, much benefit will be experienced by the application of the red precipitate ointment to the ulcers. Under this treatment we have repeatedly observed large ulcers of this kind heal with unusual rapidity.

Rest and a plain nourishing diet will be commonly best suited to people with chilblains; and should symptoms of debility and a sloughing of the sore ensue, it may be then necessary to give freely wine and bark.

SECT. IV. *Of Cancer of the Skin.*

The skin is frequently attacked with cancer. That of the face is more particularly exposed to it; and this no doubt arises from its delicacy, from the great number of vessels which penetrate it, and perhaps also from its more frequent exposure than any other part of the body to external irritations. Cancer, however, is not confined to the skin of the face; it frequently appears on the back of the hands, and on the feet. Wiseman has seen it on the cranium, Gooch on the inside of the thigh, Richter at the umbilicus; and we have seen an example of it in the skin above the pubes.

When cancer affects the skin, it begins in the form of a small, hard, and dark-coloured wart, which increases very slowly in size; the contiguous skin becomes hardened, forming a stool or button around the wart. The progress of this disease in the skin has always been observed to be more slow than cancer in any other part; so that it often remains in the form of a black scab for many years. The scab at last separates, and then an ulcer of the skin is exposed, having all the characters of the true cancerous sore. It has a pale colour, ragged hard edges, and unequal surface; and it gradually extends in an irregular manner along the skin; the hard tumor which forms its basis, at the same time increasing in size. Instead of pus, the ulcer di a thin ichor, which reddens and excoriates the skin. The disease which, when in the form of gave little uneasiness, now becomes painful; patient feels more or less frequently sharp lan pains darting through the tumor, and extendin adjacent soft parts.

When a cancerous affection of the skin is ex after it is removed from the body, it has all t ing characters described in our general obser on cancer *. The great degree of hardness of t bid mass, is produced from the formation of t fibrous-looking matter observed in all schirrous t and the direction of its fibres will be generally extending from the base of the tumor to the sur the skin.

Cancer of the skin follows the same progress a cerous affections of other textures. The cont glands become enlarged and ulcerate; and bo ulcers which these form, and the primary one, over whatever parts they meet, till they destr patient.

Treatment.—The success which has been attri to various medicines, particularly to arsenic and corrosive applications, in the cure of cancer, has chiefly from the use of these medicines in canc affections of the skin. From the disease being obs in the skin before it has far advanced, from its slow gress in that part, and the ready application of r dies, it affords better opportunities for experiment other parts of the body when affected with that ease. Past experience, however, leaves us but room to hope for a cure of cancer in the skin by external application with which we are as yet acqu ed; and we know of no remedy to be trusted to bu complete excision of the diseased parts.

The more early the tumor is removed, the great the chance of a permanent cure of the disease. in whatever part of the body the skin is affected, of the utmost importance to remove every part w there is the least suspicion of contamination. In face, we have often observed the surgeon too anx to save skin, with a view of lessening the blemish an extensive scar; but in a disease so deplorabl cancer, no object of this kind can in any degree c pensate for being exposed to the smallest risk of its turn; the more so, especially as we have often rema ed that a second operation is seldom if ever atten with permanent advantage. The surgeon, theref ought to lay it down as a general rule, that he sh include in the incision a considerable portion of sound skin surrounding the diseased parts.

The particular cases wherein an operation is advisab must be left entirely to the judgment of the surge The operation may be performed in all cases where t diseased parts appear to be within the reach of the knif or if there are any glands affected, if these can be saf ly removed, it may be even under these circumstanc undertaken, though no doubt the chance of a return the disease in such cases is great.

Whenever the periosteum and parts surrounding ar of the bones is affected, there is little chance of any assis ance from art, except when the disease occurs in the e tremities of the body, as in the hands or feet; for in suc cases, amputation of the whole member may be performe

Whe

Cancer of the Skin.

When cancerous sores appear about the eyelids, and spread along the sclerotic *conjunctiva*, it is the only safe practice to remove the whole contents of the orbit. The different parts which compose the eyeball and its appendages, seem to have such a close connection with one another, that it is difficult, perhaps impossible, to mark the boundaries of the diseased action which is going on; and as the loss of any part of the organ prevents the others from performing their functions, it becomes no material object to save any particular part.

It is generally remarked, that the lips are particularly subject to cancer, at least in men; and that the under lip is more liable than the upper one. The diseased part may be removed in this part of the body with great neatness upon the general principles of the operation of harelip. This can only be done when the diseased portion is not very large, and can be included by two incisions forming an angle, inclining towards the chin. See Harelip. When, however, the disease has spread over a considerable portion of the lip, so as to prevent the sound parts from being united, after the diseased parts have been removed, all that can be done is to remove the parts affected, secure the bleeding vessels, and dress the sore like any other recent wound.

By a little contrivance, much may sometimes be done by making the incision in such a manner as to allow the sound parts to be afterwards brought together and united; so that in all cases of extensive disease, the surgeon should consider all the different modes by which the diseased parts may be removed with most advantage.

The operation is performed by some with a common scalpel, by others with scissars. When the scalpel is used, the lip is to be held firmly with forceps by an assistant, and the second incision made along their edge; but when the disease extends beyond the adhesion of the lip to the jaw, no forceps are necessary.

The scissars are, however, the preferable instrument; they divide the lip with much less pain, and with a mathematical precision. When they are used for this purpose, it is necessary that they be thick and strong; as in some people the lip is extremely thick, and apt to slip through the blades, instead of being divided. Giving the cutting edge of the blades a knife edge, will be found an improvement on the common edge given to scissars. It is evident, however, that the scissars can only be employed in those cases where the forceps could be used to aid the knife. All wounds of the lip heal best and most accurately with the twisted suture; so that the edges should be brought together in the same manner as recommended in the case of harelip, and the same mode of after-treatment is also to be pursued.

Sect. V. *Of Warts.*

There are two kinds of Warts which grow upon the surface of the body. One species is connected with the skin by a broad base; is of a hard, firm texture, unequal on the surface, and free from pain. Warts of this description are frequent in young people, and are generally found on the hands.

Warts.

The other species of warts are attached to the skin by a slender pedicle; they have a very unequal surface, appearing as if composed of an aggregate of small tumors. Warts of this kind seldom attain any very considerable size, though we have in a few instances seen them as broad as a half-crown piece. They are seldom troublesome; but in some situations they become extremely irritable, and produce, especially when injured, very disagreeable sensations.

This species of wart is most frequently met with on the prepuce and glans of the penis; on the labia; around the anus, and also frequently upon the hairy scalp. In these situations they sometimes acquire a very large size, numerous warts arising over the whole surface, and forming a mass of a cauliflower appearance. They are most frequent in people advanced in life, and are often connected with the venereal disease.

Besides these, there are varieties of small warts which occur in different parts of the body, which have not been accurately described by authors. There is one of those, where a number of small whitish tumors appear in some parts of the face of children. These contain an opaque white fluid, which when discharged, and allowed to remain upon the contiguous skin, contaminates it, and produces warts of the same description.

Of the treatment of Warts.—A variety of local remedies have been applied for the cure of warts; and these generally possess a corrosive quality.

Lunar caustic is one of those which generally answers best; and it is most easily managed for destroying the first species of warts which we have described. A saturated solution applied to the warts three or four times a day, of the muriate of ammonia, and tincture of cantharides, has also been found beneficial in promoting their absorption.

In the second species, when the excrescences are very large, they should always be removed along with a portion of the adjacent skin, by the knife. In those cases where the warts are very numerous, and where, from their situation, it becomes impossible to remove them with the knife, equal portions of *ærugo æris* and savine powder, or savine powder alone, will be found sometimes to succeed in removing them. In some cases, particularly where the warts are situated about the glans of the penis, we have found a saturated solution of the muriate of mercury in spirit of wine, completely answer the purpose. In those cases connected with syphilis, besides local applications, it is necessary to use mercury. Sometimes, indeed, the warts drop off whenever the mercury begins to affect the constitution.

Sect. VI. *Of Corns.*

A corn is a peculiar hardness and increased thickness of the epidermis, which sometimes extends to the subjacent skin. It frequently elevates itself above the skin, and is not unlike one species of wart. It is hard, dry, and insensible, except when pressed upon the contiguous parts; and it resembles in colour and appearance the thickened cuticle on the hands of workmen. Corns commonly are formed on the toes and sides of the feet, and they are generally owing to the wearing of tight shoes. Sometimes corns do not occasion the least inconveniency; but in other instances they produce so much

Corns. much pain, that the patient walks with difficulty. Corns are generally more painful in warm than in cold weather. The pain seems to arise from an inflamed state of the parts in the circumference of the corn, which state is excited and kept up by the pressure of the induration, and not from any sensibility in the corn itself. They are more painful in dry than in moist weather, because they then become much more hard and dry.

Treatment of Corns.—The pain and difficulty of walking produced by corns, may be alleviated by immersing them in warm water, and with a sharp instrument cutting off their external layers; much relief will also be found by covering the part with a piece of adhesive plaster, and by being careful not to wear shoes which are too tight. But what we have found a most complete cure for corns, is the application of one or other of those corrosive substances which were mentioned for the treatment of warts. The lunar caustic, or the saturated solution of muriate of mercury in spirit of wine, ought to be preferred. They may be applied once every second or third day, until the absorption of the corn be completed; and, before using them, it will be proper to pare off some of the external hard layers of the corn.

Some corn-operators extirpate the corn by a sharp instrument; but this only proves a palliative treatment, for sooner or later a hard substance is again formed.

Sect. VII. *Of Nævi Materni.*

Nævi materni are those marks which frequently appear upon the bodies of children at birth, and which are supposed to originate from impressions made on the mind of the mother during pregnancy. They are of various forms; their colour is likewise various, though most frequently resembling that of claret or port wine. Many of these marks are perfectly flat, and never rise above the level of the skin: these do not require the assistance of surgery; but in some cases they appear in the form of small protuberances, which frequently increase to a great size in the course of a few months. They appear to be soft and fleshy; of a cellular texture, the cells containing liquid blood. They may be removed with little danger when not involving any important organ. They are supplied indeed more plentifully with blood than most other tumors are; and even sometimes they appear to be entirely formed of a congeries of small blood-vessels; but the arteries which supply them may be, for the most part, easily secured by ligature. An operation should never be long delayed; for as the size of the vessels corresponds with that of the tumor, they sometimes are so large as to throw out a good deal of blood before they can be secured. In performing it, the tumor is to be cut out, the arteries taken up, and the remaining skin brought as well together as the nature of the part will allow, and kept so by adhesive plaster or suture.

If the whole tumor be removed, little hæmorrhagy generally follows; but if the smallest portion of the diseased vessels remain, not only a troublesome bleeding follows, but the tumor is quickly reproduced by an increased exuberance. Tumors of this kind have also been removed by ulceration artificially excited by corrosive applications; and a knowledge of this circumstance might be in some cases of practical application.

Chap. III.

Diseases of the Mucous Membranes.

On the Diseases of Mucous Membranes.

General Remarks on the Pathology of the Mucous Membranes.

Though at first sight it may appear that the mucous membranes are very considerable in number, yet when viewed more generally, they appear limited; and we find that in all parts of the body they are subject to the same morbid alterations of structure.

Bichât has described two *general* mucous surfaces, of which all the others are portions. The one lines the interior of the mouth, nose, and the anterior surface of the eye. It is prolonged into the excretory ducts of the parotids, and submaxillary glands. It passes into all the sinuses, forms the conjunctiva, enters the lachrymal points, the lachrymal sac, the nasal canal, and is continued into the nose. It lines the pharynx and eustachian tube, the trachea and bronchiæ. It goes down the œsophagus into the stomach, and passes along the whole intestinal canal till it joins with the skin at the extremity of the rectum. This he calls the *gastro-pulmonary mucous surface.*

The other general mucous surface, the *genito-urinary*, begins in the male at the urethra; passes along that canal into the bladder, lines the bladder, vesiculæ seminales, and vasa deferentia, along with their numerous branches. It also extends into the excretories of the prostate gland, the ureters, and the pelvis of the kidneys. In the female it begins at the vulva, penetrates the ureter, and passes as in the male over the urinary organs. It also enters the vagina, lines the womb and fallopian tubes, and is then continued with the peritoneum. This is the only example of a communication established between the mucous and serous surfaces.

This view of the extension of mucous membranes is strongly exemplified by an examination of their diseases; for it will appear that there is not only an analogy between the different portions of the first, by a simultaneous affection of the whole parts over which it extends, but there is also a line of demarkation between the two mucous surfaces, from the one remaining sound whilst the other is affected throughout. This last circumstance is confirmed in the history of many epidemic catarrhs; one of these membranes having been observed affected throughout, whilst the other remained unchanged. The epidemic observed at Paris in the year 1780 had this character. "This epidemic (says Pinel*) which was very general in Paris, and with which I was myself attacked, was remarkable; for it affected almost the whole mucous membranes, that of the trachea and bronchiæ, the conjunctiva, the pituitary membrane, the palate, the pharynx, and the alimentary canal." The epidemic catarrh of 1752, described in the Memoirs of the Medical Society of Edinburgh, is an example of the same kind; for in all these, the mucous membrane only lining the urinary and genital organs remained unaffected.

* Nosographie Philosophique, tom. ii. p. 205.

We also observe that an irritation of any part of a mucous membrane frequently creates a pain on a part of the membrane which was not irritated. Thus a calculus

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culus in the urinary bladder produces the chief pain at the point of the penis, and worms in the intestines produces itching at the nose.

Among these phenomena, which are purely sympathetic, it is seldom that a partial irritation of one of the mucous surfaces produces pain in any part of the other. The singular connection which subsists between the membranes of the uterus and bronchiæ in mucous hæmorrhagies is, however, an example of this kind. If the blood accidentally cease to flow from the one during menstruation, the other frequently supplies the functions of the first. In cases of stricture, or thickening and disorganization of the mucous membranes of the urethra, the stomach is sometimes affected: this may also arise from the sympathy of the two mucous membranes.

Mucous membranes, from being constantly exposed to the action of the external air, or to the contact of extraneous substances, do not suffer, when displaced, like other parts of the animal economy. In a prolapsus of the uterus or rectum, their mucous surfaces serve all the purposes of skin; and surrounding bodies do not produce more pain on them than on common skin. This is very different from the effects produced on opening a *serous* cavity or the capsule of a joint. The cellular, muscular, nervous, glandular, and other systems, when laid open, produce also very different phenomena.

The mucous membrane, like the skin, is organised in such a manner as to endure with impunity the contact of external bodies; these merely producing an increased secretion of thin mucus. A sound introduced and retained in the bladder produces no alteration in the structure of the mucous membrane of the urethra; and for the same reason, a style or tube can be kept in the lachrymal duct without causing any irritation. The gradual loss of sensibility of mucous surfaces is strongly exemplified in the tricks of the Indian jugglers.

Most of the diseases of mucous membranes come within the province of the surgeon; the others have been already treated of under the article MEDICINE.

SECT. I. *Inflammation of Mucous Membranes.*

The contact of extraneous and irritating substances, acrid vapours, or the sudden exposure to cold air of any mucous surface, is often followed by inflammation.

A preternatural degree of redness is a constant symptom of inflammation in all parts of the body; but the most remarkable character of inflammation in mucous membranes, and that which distinguishes it from all others, is the secretion of a puriform fluid. The mucus, which in the natural state is nearly transparent, and merely moistens the surface, becomes of a yellow colour, and the quantity is so abundant as to form a puriform discharge. It is from the susceptibility of the mucous glands to be acted upon by any irritation which is applied to the extremities of their ducts, that the stone or any tumor of the bladder, polypi of the nose or vagina, are always accompanied by a profuse mucous discharge.

The inflammation is accompanied with more or less thickening of the membrane; and sometimes this remains after all the inflammatory symptoms cease. The abatement of the inflammation is marked by an increase in the thickness of the discharge and a diminution in its quantity.

Gonorrhœa.

We have an example of inflammation affecting the mucous membrane of the nose in coryza, the ear in otitis, the urethra and vagina in gonorrhœa, the bladder in a catarrhus vesicæ, the eye in the puriform ophthalmia, and the lachrymal sac or duct in fistula lacrymalis. In all these diseases the symptoms have a striking analogy, and are varied only from a difference in the functions of the particular organ, the mucous covering of which has been affected.

During life, mucous membranes become gangrenous much more seldom than the skin. This is proved from the consequences of catarrh, compared with those of erysipelas. There are, however, cases where this texture dies, whilst those adjacent continue to live; as in the malignant angina.

SECT. II. *Of Inflammation of the Mucous Membrane of the Urethra.*

Gonorrhœa (*Ecoulement Muceux*).

The term gonorrhœa is employed to signify a discharge of puriform matter from the urethra or prepuce in men, and from the vagina in women; whether proceeding from a syphilitic or any other irritating cause.

The gonnorhœa may be defined a discharge of a contagious, puriform fluid, which comes from the mucous glands of the urethra, and membrane which lines that canal; or from the glans in men, and the interior of the genital organs in women. The disease seems to be produced by a *virus sui generis*.

This disease generally makes its appearance in three or four days, sometimes in six, but rarely later, after impure coition, with the following symptoms. The patient finds a particular itching and disagreeable sensation at the point of the yard, and a slight itching also at the part of the urethra placed immediately under the frenum. These last one or two days, and on the following days the orifice of the urethra becomes sensible and red; it also swells, and a limpid matter of a clear yellow colour flows from it, which tinges the linen. Whilst the flow of this matter continues, the titillation becomes stronger and more painful, particularly in making water; for this leaves a burning impression and sharp pain in the affected part. In some individuals the first symptom presenting itself is the discharge of a thick mucus. In these cases the patient feels from the commencement a burning and painful sensation in making water. These symptoms generally increase in three or four days. Sometimes, however, that does not sensibly happen till after eight or twelve days. The glans acquires a deep red livid colour; the discharge increases, and the matter becomes of a yellow, or greenish yellow colour, resembling pus diluted. The swelling of the glans, and also of the whole penis, becomes considerable; the patient has frequently a desire to make water, and he finds, particularly when he has remained for some time in bed lying on his back, frequent and involuntary erections, so painful that they disturb his sleep, and oblige him to rise out of bed.

Such is usually the progress of the disease when the inflammation is simple, slight, and superficial; but in many cases the inflammation extends farther and penetrates more deeply, affecting the reticular substance of the cavernous

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cavernous body of the urethra. Then the pain becomes excessive, particularly during erections, and the frenum of the glans is drawn downwards as by a cord, in such a manner that the body of the penis is forced upwards by the violence of the erection. It is this symptom which is called *cordee*. It sometimes happens, that the vessels of the urethra are thus torn, and occasion considerable hæmorrhagy. At other times, the discharged matter is mixed with streaks of blood; the prepuce is also so much inflamed and swelled that it cannot be pulled back over the glans, or if it has been pulled back, it cannot be again brought forwards. In some cases the strangulation which accompanies this last accident, produces a mortification of the glans, and even occasions the death of the patient; this, however, seldom happens.

In some persons one or more of the inguinal glands swell, become painful, attended with symptomatic fever. Often the glands of the penis swell also, a cord or knots can be felt on the back of the penis, and the skin is also swelled and painful. Besides these symptoms, the patient often feels, either from his own fault, or on account of bad treatment, a particular uneasy aching sensation, with tension and swelling of the spermatic cord and testicles, accompanied with a diminution, or even a complete suppression of the discharge by the urethra. In other cases the disease makes greater progress; the irritation and inflammation stretching along the canal of the urethra. All the symptoms then become more violent, the pain which is felt in the perinæum, or behind it, in making water, is so violent, that the patient is afraid to make the attempt, at the same time that he is frequently solicited by the fatiguing titillation at the neck of the bladder and anus. There is a perpetual desire to let off the water, whilst he can make no more than a few drops at a time with a burning pain. The whole canal of the urethra is swelled, and in a state of tension; the patient has frequent erections, and lancinating pains along the canal, through the perinæum and anus. He cannot lie down for a long time, nor can he rest seated. In this state the swelling of the glands of the urethra, and the spasmodic contraction of its internal membrane, obstruct the free passage of the urine, and allow it to flow in a very thin bifurcated stream, or drop by drop; and if at the same time the discharge diminish considerably, or totally stop, a complete suppression of urine sometimes succeeds, occasioned by the inflammation and stricture of the neck of the bladder, or by the inflammation and swelling of the prostate gland and adjacent parts.

It sometimes happens that the inflammation of the urethra becomes so violent, that its internal surface, and the orifices of the glands which line it, secrete nothing; the same as we observe sometimes happens in inflammation of the mucous membrane of the nose and of the lungs. It is this state of the disease which some authors have described under the name of *gonorrhœa sicca*.

After the symptoms have continued with more or less violence, or when they have increased during one, two, or three weeks, or even during six or seven, according to the treatment employed, they begin gradually to diminish. The difficulty and the frequent desire to make water cease; the erections are no longer painful; the matter acquires more consistence, and forms into threads between the fingers, and at last the discharge entirely disappears. In other cases, and these the most frequent, the inflammatory symptoms disappear by degrees; but the discharge remains during weeks, months, or even years. It is this form of the disease which is called *gleet*, or simply *blennorrhœa*.

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Sometimes the inflammatory symptoms disappear by degrees, and leave in the urethra an ulcer, from which there is a malignant and purulent discharge, and which occasions an affection of the system. This is what has been called *gonorrhœa complicata* or *ulcerosa*; but it occurs rarely.

In other cases a contraction remains in the canal of the urethra; sometimes a paraphymosis continues, and sometimes there is a tumor of the testicles, a hardening of these parts or of some of the glands of the urethra, an inflammation of the prostate gland, with a more or less complete suppression of urine; at other times, though very rarely, the discharge, when suppressed, produces suddenly a perfect deafness, or most violent ophthalmia *.

The exciting cause of syphilitic gonorrhœa is always the application of the specific virus to some part of the mucous membrane lining the urethra. The contagious fluid, applied to any part of the body of a sound person, acts with more or less difficulty, according to the difference in the structure, the greater or less debility of the part, and also according to the particular constitution of the individual; for we see some people exposed to every danger of infection never have the disease. Perhaps also the violence of the action of the virus depends on the greater or less degree of acrimony of the virus itself.

The seat of gonorrhœa is always at a small distance from the orifice of the urethra; under the frenum, at that part of the canal where we observe a dilatation, called *fossa navicularis*. All gonorrhœas which are situated more anteriorly on the curvature of the penis, in the *veru montanum*, the neck of the bladder, or in the bladder itself, arise from bad treatment, or from some cause which has stopped or suppressed the primary discharge.

Sometimes by the natural progress of the disease, and more frequently from faults committed by the patient, or by the effects of improper remedies, the inflammation and irritation are apt to change their place. They often occupy the orifice of a mucous gland which opens at the first turn of the penis. At other times they affect the two glands of Cowper. Sometimes they occupy the protuberances which cover the orifices of the seminal vesicles; and they also sometimes affect the prostate gland, or the neck of the bladder.

In some rare cases the contagious virus does not penetrate into the urethra, but applied to the extremity of the penis, it fixes itself upon the corona of the glans, and irritating the excretory ducts of the sebaceous glands, produces a discharge which has been called the *gonorhœa of the glands*.

When the urethra of a person who has laboured under gonorrhœa is laid open, no ulcer is almost ever found upon the surface of the internal membrane; and in those who have suffered much in consequence of the disease, there is merely a thickening and contraction of one or more parts

* *Traité de Maladies Veneriens par Swediaur.*

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parts of the urethra. Sometimes, though very rarely, excrescences are formed within it. The ducts of the mucous glands are obliterated, and the prostate gland and bladder changed in their structure.

It has been a matter of great dispute among those who have written on the venereal disease, whether the gonorrhœal and venereal virus are the same. In this controversy a number of very futile arguments have been brought forward. It is a striking fact, however, which the practical man must have always in view, that the venereal disease is never cured without mercury; whilst a gonorrhœa, however virulent, never requires that remedy. This difference in the treatment of the diseases some authors have attempted to explain, from the difference in the structure of the parts affected. It is remarkable, however, that the matter from the gonorrhœa never affects the skin, producing chancre; but that when its virus is applied to the vagina, or to the urethra of another person, gonorrhœa is the consequence. When it affects the prepuce too, it produces, in place of chancre, a morbid discharge from the sebaceous glands of that organ. It is also a striking fact, in the history of gonorrhœa, that however long it may remain, it never produces any constitutional affection. All these circumstances in the history of the disease, in its progress and symptoms, and in its cure, being so dissimilar to those of the venereal disease, are surely sufficient grounds to consider gonorrhœa and syphilis as two distinct morbid affections, and different from one another as much as any two diseases of the animal economy.

Specific nature of the virus.

Treatment.—All the forms of syphilis, when left to themselves, undermine and destroy the constitution; but gonorrhœa ceases without the resources of art, particularly if during its course the patient live a sober and regular life. The irritability of the urethra, the constitution of the patient, faults in diet, in exercise and choice of remedies, and perhaps also the nature of the virus itself, being more or less acrid, and of which the action will be more or less violent, often renders gonorrhœa a very severe disease. Experience confirms, that the sooner proper remedies are applied, and the sooner the patient is cured, the less he suffers; and the more certainly he avoids the disagreeable accidents which are so often the consequence of that disease. From this consideration, it is evidently of importance, either to prevent the disease entirely, or destroy it in its beginning. Two means have been proposed to accomplish these ends; one is, to remove the virus before it can act on the parts exposed to it; the other destroys and alters its nature, and prevents these effects from the moment that it gives the first signs of its action.

Different practitioners have tried and recommended various prophylactic remedies. Some have applied mercurial ointment upon the surface of the glans and prepuce, immediately after coition, and others different lotions and injections, as caustic alkali, lime water, alcohol diluted with water: these preparations being injected seven or eight times a-day, for several days after the commencement of the discharge.

By the use of injections the irritation is diminished, and the progress of inflammation stopped; and when the discharge becomes thicker during their use, they ought to be continued eight or ten days after it has disappeared; for if we were to give up too soon the use of these injections, the inflammation and discharge would increase. In this case it is necessary to make the injection stronger, and to use it more frequently. The advantages to be derived from this practice do not seem, however, to be altogether confirmed; and it is to be wished that enlightened and prudent practitioners would make some decisive experiments to determine whether injections are useful or hurtful in the commencement of gonorrhœa.

When inflammation has taken place, and when the discharge and other symptoms of gonorrhœa are completely formed, a different mode of treatment ought to be pursued. Repose, abstinence from all kinds of irritating food, wine, &c. will contribute much to allay the irritation.

In order to defend the irritable parts against the acrid matter, and to moderate the symptoms of inflammation, authors have recommended the use of mucilaginous, oily, and sedative applications. That which renders the urethra in man so violently affected by gonorrhœa, and so different from catarrh, is not from the difference of structure in the organ, which has been supposed to be more irritable than the mucous membrane of the nose and other parts of the body. It is the salts of the urine passing along the urethra, which keeps up the irritation produced by the virus. It has been proposed, in order to remedy this source of irritation, to give gum arabic or the infusion of linseed internally; but these, when taken in the necessary quantities, generally injure the stomach. An infusion of hemp has been found by Swediaur to answer all the purposes, and not to be subject to the inconveniences of the others. This remedy may be rendered more agreeable to take, by adding a little sugar to it; and in some cases a weak decoction of sarsaparilla may be advantageously added. All these drinks should be taken cold, or at least nearly milk-warm, and in small doses frequently repeated.

The antiphlogistic regimen must also be pursued in the treatment of gonorrhœa. The patient ought to avoid all exercise, or high-seasoned food. Lint, wet with a saturnine solution, should be kept constantly applied to the penis; and the patient should keep his bowels open with saline purgatives. When the symptoms of inflammation are considerable, and the pulse hard and frequent, bleeding becomes necessary, either general or topical: the constant application of fomentations and emollient poultices is also useful. Swediaur has advised, that camphor and the nitrate of potash should be given internally, and this should be continued according to its effects. Camphor alone, taken in the form of emulsion with sugar or fresh egg, is an efficacious remedy in allaying the pain and *ardor urinæ*. The use of camphor has also been recommended externally, with a view to allay the cordee.

These remedies ought to be continued as long as the pain and symptoms of inflammation in the urethra continue. After these are abated, the patient may be allowed a better diet, in order to prevent the urethra from being affected with a chronic gonorrhœa or gleet. Injections made of the extract of opium with acetate of lead, applied frequently from the commencement of the disease, contribute much to shorten its duration, and allay the accompanying pain. Sometimes, however, even the most mild injections do harm, from a particular irritable

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state of the urethra. Great advantage has also been obtained by some, in very aggravated cases of the disease, by frictions of mercurial ointment on the perinæum, and along the course of the urethra, by opiate plasters, or by mercurial fumigations applied to the genital organs, and even by the injection of mercurial ointment into the urethra.

On the other hand, when the symptoms of erysipelatous inflammation prevail; when the patient is feeble, and of an irritable temperament; when he feels better after dinner; when the discharge is clear and profuse, accompanied with sharp pain, often lancinating throughout the whole urethra; and if the pulse is feeble and frequent, it is more adviseable to give him a less rigid diet; to allow him the moderate use of wine, and in some cases to give him opium and bark internally. We are sometimes surprised at the sudden changes which these remedies in such cases produce. The use of opium also contributes much to prevent cordee; and in all cases this ought to be avoided as much as possible, by fixing the penis downwards, and by making the patient lie on his side upon a mattress, which answers better than lying upon the back, and in a feather bed.

If in consequence of the violence of the inflammation the discharge stops, and the posterior parts of the urethra begin to be affected, we should have recourse to bleeding and the warm bath, or apply vapours to the part, by placing the patient upon a vessel containing boiling water, and this should be repeated three or four times a-day; the patient should keep in bed, and an emollient cataplasm be applied upon the penis. All kinds of injections in such cases are hurtful. The same treatment is also applicable when the discharge is stopped by the use of acrid and astringent injections, or by injections improperly used, or by the improper use of turpentine and balsams.

When the prostate glands and the neck of the bladder are affected, and the patient of a plethoric habit, it becomes necessary to bleed profusely, either at the arm, or by applying a number of leeches to the perinæum. In all these cases, a sedative cylster repeated every seven or eight hours, and a general or local warm bath used twice a-day, are the best remedies. Sometimes a blister applied to the perinæum is also useful.

The swelling of the lymphatic glands of the groin which sometimes takes place, is purely sympathetic, and disappears along with the inflammatory symptoms of the urethra.

In all cases of gonorrhœa the patient should wear a suspensory bandage whilst the disease continues *. It is also useful to persons who are obliged to take exercise, to wear a convenient bandage round the penis, which may be united to the suspensory in such a manner, that the penis may be enclosed in a kind of case, and thus defended from external injuries, from cold, and from friction; this bandage being kept constantly clean, by often changing the caddis, which is placed in its cavity. For this purpose, a hole should be left in the bag, covered by the caddis, which the patient can take away each time he makes water. Another general precaution which it is useful to make, is never to keep the penis bound up high, but to keep it low, in order that the matter may flow out freely, and may not pass backwards along the urethra.

* Plate DXIV. fig. 12.

The gonorrhœa of the glans and prepuce is generally easily cured, by injecting frequently warm milk between the glans and prepuce, and by keeping the penis in an emollient poultice. In those cases where the prepuce is so swelled that it cannot be pulled back, we ought to have recourse to sedative injections.

It is a useful general rule, which ought to be observed in all cases of gonorrhœa, to touch the parts affected as little and as seldom as possible; and every time they are touched, to wash the hands immediately afterwards, and with the greatest care, fearing that, by carrying them unintentionally upon the eyes, or nose, these organs might be inoculated with the disease.

In women.

Gonorrhœa in women is seldom followed by so violent symptoms, or by so severe and dangerous consequences as in men. In some cases the symptoms are so slight, that they conceive the discharge, particularly at its commencement, to be nothing but the whites, to which disease a great many are subject, especially in the large towns of Europe.

The gonorrhœa in women has been supposed by many authors to have its seat in the cavities of the urethra. This, however, will not be found the case. The disease is seated, either upon the clitoris, or on the orifice of the urethra; upon the nymphæ, or in the cavity of the vagina; or even upon the inferior commissure.

Treatment.

With regard to treatment, the same indications are to be fulfilled in gonorrhœa in women as in men, with this difference, that one can see the change of structure in these parts, and thus, from the seat of the disease, employ proper injections and lotions from the beginning.

Precautions in using Injections.—The syringe used in men for this purpose ought to have a short point of a conical form and of a thickness proportioned, that not more than its extremity may pass into the orifice of the urethra *. The body of the syringe should be perfectly cylindrical, and the piston play very accurately; for if the piston does not fit the body of the syringe, the injection, instead of passing into the urethra, regurgitates between the piston and the syringe. From the unsteadiness of the motion of the piston, the point of the syringe is also apt to move suddenly on the urethra, and injure its thin and delicate membrane. To prevent any injury of this kind, we have employed with great advantage, particularly if the mouth of the syringe is made of metal, a small strip of caddis wrapped in a spiral manner round the mouth of the syringe, so as merely to expose its point. If the disease be seated near the point of the urethra, the patient should be attentive to compress with one hand the urethra above the arch of the pubis, where the scrotum commences, whilst with the other he holds and guides the syringe. The liquid should be thrown in gently, so as slightly to distend the urethra, and be kept for a minute or two; the same operation being repeated two or three times in succession.

* Plate DXIV. fig. 12.

The liquid employed should always be used warm, which may easily be done by filling a cup with the necessary quantity, and placing the cup in a bason of boiling water.

It often happens, particularly in young people, that after

Gleet.

after having used injections some time with advantage, they become less attentive, and neglect them for a day. This omission is always followed with bad consequences, the discharge returning with double force; and the patient is obliged to continue the injections during some weeks more than would have been necessary, if the use of the remedy had not been interrupted.

In order, therefore, to prevent the danger of a relapse, it is always prudent that patients inject three, four, or even six times a-day, if the circumstances demand it, and to continue the same two or three times a-day regularly for at least ten or fifteen days after the discharge has entirely ceased.

For women the canula ought to be larger and longer. A canula of ivory, an inch in diameter, and two or three inches in length, fixed to a bottle of elastic gum, is the most convenient form of a syringe *.

* Plate DXIV. fig. 15.

Of Gleet.

It very often happens, that even after the specific inflammation of the urethra is removed, from which gonorhœa is supposed to originate, a discharge continues. This discharge is not generally attended with pain, nor can it be communicated from one person to another. The matter which escapes is generally of a tenacious consistence, and of a yellow colour, appearing to be composed of globules, mixed with a mucous fluid. When a cure cannot be procured either by the use of injections, or by bougies, it has sometimes been proposed to inject liquids capable of exciting irritation and inflammation in the affected part of the urethra. It is probably on this principle that some gleets have been cured by violent exercise on horseback, or a long journey. There have also been cases cured by coition; but this is not to be recommended, as there always may be a certain risk of communicating the disease to the women. A blister, applied externally to the part affected, or to the perinæum, has also been found useful. The cold bath has often been recommended in obstinate gleets, from which good effects often result; but there are other cases in which it seems to increase the discharge.

It is also proper frequently to change the injection; for it is observed that an injection less strong sometimes produces a good effect, after a strong one has been employed without success, and *vice versa*. In many cases it is useful to combine internal medicines with external means. The chief are mercurial preparations, balsamic and resinous substances, and tonics. Swediaur has used, with much success, in gleets, pills made of turpentine and oxide of mercury. Among the resinous substances which are employed, the most common is the balsam of copaiba. The best way of taking this remedy is to give from thirty to sixty drops in a small glass of cold water three times a-day, and afterwards to take, in a small glass of water, twenty drops of the elixir of vitriol, which renders the balsam less disagreeable to the stomach. Half a dram of turpentine, of the balsam of Tolu, or of the balsam of Canada, answer the same end. Swediaur mentions the case of a young man, who, having been for a long time distressed with a very obstinate gleet, swallowed at once between two and three ounces of the balsam of copaiba, and was cured.

Sometimes the balsams, combined with tincture of guaiac, or with kino, produce a desireable effect.

Among the corroborant or tonic remedies, the kino, which we have already mentioned, is one of the most useful; the cinchona also in powder or infusion in red wine, or, which is still better, in lime water; tormentilla in powder, or in extract, in the form of pills, joined, according to circumstances, with preparations of iron, are useful and efficacious remedies. The tincture of cantharides, given in a dose from twenty to thirty drops three times a-day, has often been found very beneficial. It is one, however, which ought to be given with precaution, as it may do much harm to people of a delicate and irritable temperament.

There are, however, cases, where all our efforts to cure a gleet are fruitless; and we sometimes see, that nature alone can in time succeed, after we have uselessly tried all the resources of art.

Sometimes there remains a species of cordee or curvature of the penis after all the other symptoms of gonorrhœa have disappeared. Frictions, with mercurial ointment, with camphorated oil, spirituous lotions, or electricity applied to the part, are most appropriate remedies in such cases.

In all cases of obstinate gleet, situated far back in the canal of the urethra, the state of the prostate gland should be carefully examined; for they often arise from a disease in that part. When the prostate is found swelled and hard, Swediaur has seen instances where, after a mercurial treatment, the repeated application of cupping-glasses to the perinæum, and the use of large doses of the *conium maculatum*, has succeeded.

The gonorrhœa of the prostate is a morbid discharge of mucus from that gland, mixed sometimes with the liquor of the seminal vesicles; and it takes place principally through the day, without any venereal desire. This disease is soon followed by feebleness and general debility, with emaciation of the whole body, and even with death; particularly if the patient has not employed proper remedies.

The remedies most efficacious are the cold bath, injections of metallic salts, fomentations of hemlock, blisters to the perinæum, and internally tonic medicines, with a well-regulated diet.

Coryza.

Sect. III. *Of Inflammation of the Mucous Membrane of the Nose.*

Inflammation of the mucous membrane of the nose is generally preceded by dryness in the nostrils, with an itching feeling, and a weight over the forehead. It is also accompanied with sneezing and an increased flow of tears. The secretion of mucus from the nose is at first diminished, and afterwards becomes very abundant. At first it is limpid and irritates the sound skin of the upper lip, over which it passes, and becomes afterwards opaque, of a yellowish white colour, and a disagreeable odour. This state is sometimes accompanied by fever, and it continues for a longer or shorter period. Most commonly it ceases at the end of a few days. It sometimes, however, becomes chronic and indetermined, in which case it is often intermittent, and re-appears at regular

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regular periods. Coryza, like all other inflammations of the mucus membranes, terminates by resolution. It sometimes passes into the state of chronic catarrh, and it also occasions an ulceration of the mucous membrane of the nose; but this is extremely rare.

Coryza is frequently accompanied with inflammation of the mucous membrane of the eye, it also spreads in many instances along the eustachian tube, producing deafness, and it is very apt to extend down the trachea and affect the lungs.

The nose is sometimes affected with a discharge of thick viscid mucus, when there is very little apparent redness or pain. Such instances are often connected with the formation of polypi: but we have observed several cases, where no other symptom than the mucous discharge appeared, and where the disease had very much the general character of some discharges from the urethra.

Treatment.—Coryza is commonly an affection so slight, and of such short duration, that it is seldom necessary to employ any vigorous means to produce an abatement of its symptoms. Somtimes, however, the symptoms go to a very high degree, and it is then that emollient vapours directed into the nasal cavities are particularly indicated. If much symptomatic fever accompanies the disease, it may be adviseable to draw some blood from the arm, and in all cases a brisk purgative will be found to relieve the fulness and uneasiness in the head. When the inflammation spreads along the mucous membrane of the trachea, it becomes the more necessary to use every means to alleviate the inflammatory symptoms, and to prevent the inflammation affecting the mucous membrane of the bronchi.

Patients labouring under this disease, feel remarkable relief from living in a warm atmosphere; and the symptoms of inflammation of the nose and trachea will be much alleviated by the internal exhibition of opium.

When the inflammation and the discharge are of a chronic nature, astringent injections, or a dossel of lint dipt in similar solutions, and kept in the nose during the night, are in such cases the most useful applications. They gradually diminish the quantity of the discharge, and render it more thick and tenacious; and the sense of smelling, which is commonly destroyed, is restored.

If the discharge be fœtid, and occasionally mixed with blood, in all probability it originates from the formation of an abscess or ulcer, connected with a carious bone.

SECT. IV. *Of the Inflammation of the Mucous Membrane of the Ear* (Otitis).

In inflammation of the ear, there is the same characters of the disease deduced from analogy of structure, as in other mucous membranes. The principal causes of this disease are sudden changes in the atmosphere; above all, the change from heat to cold, or from dryness to moisture; coldness of the nights, north winds, suppression of any regular discharge, the crisis of acute diseases, metastasis, the presence of an irritating body in the ear, or the imprudent application of oily or spirituous substances.

The inflammation sometimes takes place in the *meatus auditorius*; and in other cases it is confined to the cavity of the tympanum and eustachian tube. In the first case, there is more or less pain, and buzzing in the ears, and afterwards a discharge of thin reddish yellow matter. This matter gradually becomes white and opaque, and increases in consistence till the termination of the disease; when it differs in nothing from the wax of the ear, but in its white colour. This affection generally lasts twelve or fifteen days. It sometimes spreads to the external parts of the ear, and often passes into a chronic state.

When the inflammation is confined to the cavity of the tympanum, it produces an obscure tingling sensation, and a feeling of tension, which the patient supports without much inconvenience; but most frequently the inflammation is propagated from the cavity of the tympanum along the eustachian tube. In this case, the pains become more violent and extend along the contiguous mucous surfaces; they pass from the interior of the ear into the throat; there is great difficulty in swallowing, and the food, when passing through the pharynx, gives a sensation as if the skin had been eroded. The motions of the neck also become uneasy, and the smallest attempt to cough, to sneeze, or blow the nose, produces a painful sensation to the ear. The patient also complains of a stoppage in the nose, of a frequent dry cough, and of pain in the head, and more or less fever in the evening. The ear also feels hard or distended, and there is generally deafness, particularly towards the termination of the disease. Soon all these symptoms diminish except the hardness in the ear, which augments continually till the fifteenth or twentieth day. Most commonly after this period, a quantity of fœtid matter is suddenly discharged into the external ear, or into the throat, and then all the symptoms disappear. This discharge generally diminishes daily, and in a short time ceases altogether. At other times, particularly in young people, it continues, and becomes chronic.

Treatment.—When the inflammation is confined to the external meatus, the disease is generally so slight that it may be allowed to run through its common periods, and it is merely necessary to keep the patient warm. When the inflammation is very considerable, the mildest injections give pain, and in place of moderating the symptoms, they increase the irritation. We ought therefore to do nothing, except, perhaps, to allow some warm vapour to pass into the ear, to apply a poultice externally, and to pursue the antiphlogistic regimen. About the twelfth or fifteenth day, it may be useful to apply tonic medicines, such as a piece of cotton dipped in aromatic alcohol. When the inflammation is in the tympanum, or the eustachian tube, besides emollients, it will also be necessary to give some brisk purgative, or to employ local or general blood-letting. If the membrane of the drum be much distended, and accompanied with violent pains, it has been proposed to make an opening through the tympanum*. When the matter has been discharged from the tympanum either spontaneously or artificially, little more is required to be done, unless the disease assumes a chronic form. This is most frequent in children. We often see the purulent discharge continue in them for many months, and some of the small bones of the ear become carious, and are discharged along with the matter. In such cases small does of calomel, for some time repeated, blisters behind the ear, and injections of lime water

* Nosographie Philosophique par Pinel.

Angina.

water combined with muriate of mercury, acetate of lead and the like, should be employed.

Sect. V. *Of Angina.*

The parietes of the mouth, trachea, and larynx, are often inflamed in catarrhal affections, and present symptoms which vary according to the intensity of the disease, and particular seat of the affected membrane.

Angina has therefore been distinguished according to its seat in the tonsils, the trachea, the pharynx, and larynx.

When the patient has great difficulty in swallowing his food, and when the pain stretches in chewing, to the ear along the eustachian tube, by a sort of crepitation, and if, on inspection of the throat, the amygdalæ and edge of the palate appear much inflamed, along with an abundant excretion of mucus, the angina has its seat principally in the amygdalæ.

Angina affects the pharynx when deglutition is difficult or impossible, and the food is returned by the nose, respiration not being at the same time impeded. This inflammation is also visible by examining the bottom of the mouth. But if the deglutition is difficult; if no redness is perceived at the bottom of the throat, and if the patient has great difficulty in respiring, a sharp pain in the motions of the larynx, the voice acute but weak, and the speech short, we may then conclude that the inflammation has attacked the larynx, or upper part of the wind-pipe. An affection of this kind, though a few cases have been known to take place in adults, generally attacks children under twelve years of age. It is known by the name of *croup.*

When the inflammation affects the amygdalæ, inhaling steams of warm water and vinegar will often be found to give great relief. A poultice, too, applied to the outside of the throat, assists in lessening the tension of the inflamed parts. Though in many cases the inflammation seems to be confined to the mucous covering of the glands, yet in others it spreads into the glandular substance, where it generally advances to suppuration. In such cases, the early discharge of the matter gives great and immediate relief; and though no matter has been formed, puncturing the inflamed part with a sharp instrument often produces an alleviation of all the symptoms. The instrument delineated in Plate DXIV. fig. 14. is well calculated for these purposes. By altering the position of the screw in the handle, the depth of the cutting part of the instrument may be regulated. When used, the fore finger of the left hand is to be introduced down the mouth, and the perforator concealed in the canula introduced as a director. When the extremity of the canula reaches the inflamed part, then the perforator may be safely pushed into it, to a depth which had previously been regulated.

When the inflammation affects the pharynx, relief will also be obtained by inhaling the steam of warm water, and by employing antiphlogistic remedies. In croup, calomel has been found to have a specific effect; and it is astonishing the quantity that has been given to infants for the cure of that disease. See MEDICINE.

When the albuminous effusion which takes place in croup, is chiefly confined to the upper part of the larynx, and produces symptoms of suffocation, it has been proposed to make an artificial opening into the trachea, below the place where the matter is effused, in order to save the life of the patient. See BRONCHOTOMY.

Of the Catarrh of the Bladder.

Sect. VI. *Of the Catarrh of the Bladder.*

The ureters, the bladder, and the urethra, are all liable to be affected with catarrhal affections from general causes, the same as those affections of the mucous membranes which have been already mentioned; and besides, the surfaces of the mucous membranes of these parts are exposed to the action of particular causes, namely, the ureters and the bladder to calculi, and the urethra to the venereal virus.

The catarrh of the bladder is more frequent among men than among women; and old people are more subject to it than those at any other period of life. It is often produced by the internal use of cantharides, and by acrid diuretics. The sudden exposure to cold, suppressed perspiration, the disappearance of different diseases of the skin, of rheumatism, and of gout, are sometimes followed by this catarrh. Other circumstances may also give rise to catarrh of the bladder. The presence of a calculus or any foreign body, the continual application of bougies, a swelling of the prostate gland; and above all, strictures of the urethra.

This disease is marked by pains of the bladder, and at the point of the urethra, both before, and whilst making water. The hypogastric region is tense, and the urine presents a variety of colours; it is sometimes whitish or reddish, or of a deep yellow colour; and it is muddy, exhaling an odour of ammonia, which becomes more sensible a short time after it has cooled. It also forms, in most cases, a mucus, which mixes and comes away with the urine in the form of glairy filaments, and which is afterwards deposited at the bottom of the vessel in the form of a tenacious glairy substance, resembling somewhat the white of an egg.

The chronic inflammation of the mucous membrane of the bladder, may be accompanied with an ulceration of the kidneys or bladder; the mucus discharged then becomes of a greenish yellow colour, sometimes mixed with streaks of blood. It is deposited slowly, is mixed easily among the urine, and in water; it has little viscidity or fœtor, and does not coagulate by ebullition. The other symptoms which accompany this excretion, as fever, pain, wasting of the flesh, sufficiently distinguish this double affection of the bladder. The chronic catarrh is subject to return with great pain in the region of the pubis and perinæum, accompanied with restlessness and anxiety. These intermissions are irregular, and may remain some weeks.

Treatment.—The matter secreted by the mucous membrane of the bladder, and other membranes of the same class, is sufficient to point out the means to be employed in its treatment. The warm bath, and mucilaginous drinks, are particularly indicated at the beginning of the acute catarrh; but the tendency which it has to become chronic, ought to make us cautious in not

prosecuting.

Strictures. prosecuting the use of debilitating remedies too far. Opium should be employed with great prudence, notwithstanding the intensity of the pain; and as this is often the result of distension of the bladder, from the accumulation of urine, it is sometimes necessary to have recourse to the introduction of the catheter.

The chronic catarrh of the bladder is generally difficult to cure, and the more so, if it occur in old age: If it arises from stone in the bladder, there is no cure but the operation of lithotomy; if it arises from metastasis, rheumatism, or any other disease, we ought to employ remedies to the skin and intestinal canal. The uva ursi has also been found a useful remedy. Exercise, dwelling in dry and elevated places, the use of woollen clothes next the skin, contribute often more to the cure of this disease, than the use of medicines, and ought always to be combined with them.

The conjunctiva covering the eye-ball, eye-lids, and lachrymal passages, are also subject to inflammation; but these will be treated of among the diseases of the eye and its appendages.

Sect. VII. *General Remarks on Strictures.*

The term Stricture has been usually applied to a contraction of the urethra; generally arising from a thickening of the mucous membrane lining that canal. This change of structure is not, however, confined to the mucous membrane which lines the urethra; the same morbid alteration takes place in the œsophagus and rectum, in the eustachian tube and meatus externus, in the maxillary sinus, in the bladder, in the lachrymal passages, and in all canals lined by mucous membranes. Strictures, however, occur much more frequently in the urethra, and are there more pernicious than in any other part. They appear also sometimes in the upper part of the œsophagus. A similar change has been observed in the internal part of the bladder. Bichât found the membrane lining the maxillary sinus several lines in thickness, and also the canals of the tympanum much thickened *; and reasoning from analogy, and from what may be observed by an attentive examination of the symptoms in many cases, of what is usually called fistula lachrymalis, there is little doubt but a contraction and thickening often take place of the mucous membrane lining the lachrymal sac and duct.

* *Anatomie Generale*, tom. iv. p. 431.

This change in the structure of mucous membranes is always the consequence of inflammation; and when the membrane is thus altered, the discharge, instead of being healthy mucus, is generally a puriform fluid, apparently a mixture of pure mucus with globules of pus.

Sect. VIII. *Of Strictures in the Urethra.*

The treatment of the diseases of the bladder and urethra has always been considered a difficult branch of surgery, as their true nature is often obscure, and as it is by no means easy to direct the proper means of relief.

Of the great variety of causes which disturb the functions of these organs, strictures in the urethra are perhaps the most frequent, and most serious. They prevent the free evacuation of the bladder; greatly disturb, if not entirely destroy the function of generation; and often give origin to constitutional symptoms which sometimes increase to an alarming degree, and even prove fatal.

Strictures of the Urethra. That the urethra should be subject to many morbid changes, we may infer, not only from our knowledge of the functions it performs, but also from its delicate and no less complicated structure.

One part of this structure is intended for the evacuation of the urinary bladder, the other for the transmission of the seminal fluid; and as in the exercise of this last function, the urethra sympathises, in a greater or less degree, with the whole system, and also with the mind itself, it must have a connection with many of the other organs of the body. Accordingly, we find that patients who have obstructions in the urinary canal, have at the same time other complaints, which get well when the obstruction is removed. And, on the other hand, diseases of other parts bring on morbid affections of the urethra, which are cured along with the primary complaint.

The whole extent of the urinary canal is lined by a delicate membrane, constantly covered with a viscid fluid, secreted by numerous glands, whose ducts open on its internal surface by orifices, which are called lacunæ. It is highly vascular, and is endowed with so much sensibility, that irritating bodies applied to it often affect, or even derange the whole system. It has a considerable degree of contractility, is evidently elastic, and perhaps may possess a muscular power, although no muscular coat has yet been demonstrated; but to whatever cause this contractility be owing, it is well known that it does not contract upon irritation. As a proof of this contractile power, a remarkable case was mentioned by Mr Cline in his lectures, where a stone, lying in the membranous part of the urethra one evening, had been expelled during sleep, and was found among the bed-clothes the following morning.

The contraction which forms a stricture in the urethra may take place round the whole circumference of the canal; it may arise chiefly at a particular point of the circumference; or, it may extend along a considerable extent of surface, thus are produced obstructions of different forms.

The stricture once begun, continues no longer than the cause which first produced it continues to operate. But if the parts are kept long in this state of contraction they generally are attended with a degree of inflammation; the membrane of the urethra acquires a morbid degree of thickness; the surrounding parts are altered in structure; and this change of form and appearance remains after the cause which originally produced them has ceased to operate.

That spasmodic strictures do exist appears from the impressions made on bougies which have been passed through them, and from the examination of the parts after death; for although complete obstructions to the bougie were found when alive, yet not the smallest remains can be observed on dissection. This contraction is peculiarly violent, and from what we have observed is more frequent, at the fossa navicularis than at any other part of the canal. A gentleman, after many attempts to make water during the night, was not able to pass a drop, and he applied for relief in the morning. A bougie was introduced, and met with a complete obstruction at the glans, which yielded

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yielded in a few seconds after the bougie was in close contact with it. On being withdrawn the urine flowed freely, and the complaint has never since returned.

Contraction at this place is sometimes so violent as for a long time to interrupt the entrance of the bougie; and in one case, after being introduced, was so strong as nearly to cut the instrument through. This happened repeatedly with the same patient.

When there has been a permanent stricture, the natural structure of the urethra is changed. There is commonly a contraction at one particular part of the canal; and its appearance has been compared to what would have been given had a pack-thread been tied round it. In slight cases it is a mere narrowing *.

When a ridge is formed projecting into the cavity of the canal, it is found to be a doubling of the inner membrane, with the cellular substance lying between the fold. The internal membrane itself is diseased; it assumes a whitish colour; becomes hard, sometimes as hard as cartilage; and in some cases this change is confined to the doubling of the stricture itself, whilst in others it extends into the cavernous bodies. These ridges or folds often form over one another, so that the intermediate portion of urethra becomes preternaturally contracted also; but it never becomes so narrow as at those parts where the original strictures were formed. Instead of a distinct curtain or fold, it happens also in some cases that the urethra has the appearance of a cone gradually converging before the stricture, and diverging in the same manner behind it.

* See Plate DXIV. fig. 6. and 7.

The contraction is generally round the whole of the circumference of the urethra: but sometimes it is only at one side, and in such cases the urethra does not form a uniform tube, but becomes serpentine and contorted in various directions.

When one stricture is formed, the portion of urethra anterior to it is liable to suffer some changes, which probably arise from its not meeting with the ordinary distension, the stream of urine being diminished. It is by no means uncommon, therefore, to find in those cases where the original stricture has been formed near the bladder, another stricture anterior to it, so that when an obstruction is found at the glans or four inches and a half from it, another is generally met with at seven inches, or at the bulb.

Situations of stricture.

From the peculiarity in the form of the urethra, some parts are much more subject to strictures than others. In the adult, and in the relaxed state, the urinary canal is about nine inches long, and nearly of the same diameter as a common quill; but its size varies at three different points, and at these strictures most frequently arise. The contractions are at the glans, the bulb, and the prostate gland (see fig. 5. Plate DXIV.). The narrowest part is just below the bulb, and here strictures most frequently occur.

The natural contraction renders it, in almost every case of stricture, the seat of the disease. This part of the canal seems also to possess an uncommon degree of irritability, as it is here that the contraction takes place in cases of strangury. When strictures continue long, and the violence of the symptoms increase, diseases arise in other parts. The urethra between the stricture and bladder, from the obstruction the urine has to overcome, enlarges, and is sometimes attacked with inflammation.

As the stricture is in most cases attended with a gleet, the glands situated about the neck of the bladder become diseased. The bladder becomes extremely thickened, and its capacity diminished, from the strong exertions it is necessary to make in order to overcome the obstruction, and as it cannot contain much urine, the ureters become dilated.

When the disease advances still farther, so that it is impossible to evacuate the bladder, from the obstruction being complete, the urine escapes by some new channel; for as in such cases the parts between the bladder and obstruction make less resistance than its coats, both on account of their natural structure, and as these parts are generally inflamed or ulcerated, they give way, and the urine takes a new course. When this change has once taken place, so that no urine passes through the meatus urinarius, the other symptoms will differ according as the aperture has been formed by ulceration of the inner membrane of the urethra, or by a sudden rupture. For when the membranous part of the urethra has been eroded, a suppurating cavity must have formed in the contiguous cellular substance, and as the urine cannot so easily be diffused in the surrounding parts, it makes its way without difficulty through the integuments. But when a sudden rupture or ulceration of the inner membrane of the urethra takes place, as the urine meets with no obstruction in insinuating itself into the cellular membrane, it effuses itself in a short time over the perinæum, scrotum, and adjacent parts; extensive abscesses are formed where the urine was diffused; and as these burst in numerous places, fistulous openings are formed, which have either a direct or indirect communication with the bladder, and through which the urine continues to pass till the original obstruction is removed.

Symptoms.—Often this complaint does not become of such importance as to give alarm to the patient till many months, or even years, after the original cause has been forgot. At other times, a few months after a gonorrhœa has been cured, the urine, instead of coming away with the accustomed ease, begins to be passed with difficulty. The stream, in place of being full and even, diminishes and becomes unequal; sometimes it comes in drops after much straining and exertion, has a forked appearance, or scatters in different directions. From the irritable state of the parts, the smallest quantity collected in the bladder, brings on a desire to make water, and a continual uneasiness along the course of the canal, about the perinæum, anus, and lower part of the abdomen. In most cases there is a discharge of matter from the urethra. The gleet is always more severe after any debauch or venereal act. It comes on immediately after such excess, and gradually diminishes or disappears. It is also not unfrequent to find strictures accompanied with that profuse discharge of mucus from the bladder called *catarrhus vesicæ*. The irritation communicated to the bladder in consequence of the disease of the urethra, brings on inflammation, which is followed by a profuse discharge of mucus from the whole of its internal surface, and this mucus comes away with the urine, and is deposited, and firmly adheres at the bottom of the pot in the form of a tough tenacious mass.

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Nocturnal emissions are sometimes the only symptoms which lead us to suspect the existence of stricture; for in some cases the disease is neither attended with any fixed pain in the urethra, nor is there any discharge of matter.

Fistulas in the perinæum, and along the course of the penis, often derive their origin from an obstruction of the urinary canal.

When, either from irritating injections, bougies, or any other cause, inflammation comes on, the urethra is completely shut at the place of the stricture, and the internal membrane giving way, the urine is effused in the cellular membrane, which gives rises to abscesses and fistulous openings, through which the urine continues to pass, till the stricture is removed. The inflammation in some cases spreads to the surrounding parts; the mucous glands inflame, suppurate, and burst; and hemorrhoidal tumors often form at the extremity of the rectum.

Besides these, the more usual symptoms of stricture, there are others which accompany that complaint, and arise from constitutional causes. The most frequent is a febrile attack, in the form of a complete paroxysm; but it differs from the common intermittent fever, in its short continuance, its irregularity, and in the violence of its termination. It happens most frequently to those who have been in warm climates; but it is by no means confined to them alone.

People of weak constitutions have often sickness at stomach, nausea, and vomiting, and sometimes an uneasy state of irritability about the stomach, which gets better when the stricture is relieved.

Gout, epilepsy, hydrocele, sciatica, erysipelas, have all been found connected with stricture; but such cases rarely occur.

There are other diseases of these organs which have so many symptoms in common with stricture, that it is necessary to inquire with much attention into the history and state of all the symptoms, before we can judge of the true nature of the complaint; and when there is any reason to suspect that an obstruction exists, it is ascertained only by the introduction of a bougie; but the mode of doing this will be explained when speaking of that instrument.

Diagnosis.

There are diseases that ought to be mentioned as being liable to be mistaken for stricture, and always kept in view in forming the diagnosis. An irritable state of the urethra, proceeding from gonorrhœa, is one that is very frequent. In such a case there is a discharge of matter and a pain in making water. The urine flows in a small stream at the commencement, but before it is all evacuated it is of the natural size. The symptoms come on a few hours after coition, but abate in a short time, and whenever the irritating cause is repeated, they return.

The bladder also, when irritated, brings on diseases of the urethra, as these parts sympathize so strongly with one another; but when the primary affection is in the bladder, there are always symptoms which aid us in discovering the true complaint.

Enlargements of the prostate gland are by far the most apt to mislead our judgment. Scrophulous and schirrous enlargements of that organ were at one time supposed to be very frequent causes of retention; it is now generally believed that they occur seldom, and are chiefly confined to people advanced in life.

It will be afterwards mentioned how swellings of the valvular process of the prostate are apt to be mistaken for stricture when a bougie or catheter is introduced. The obstruction in such a case is always at a distance, as the canal has increased in length from the enlargement of the parts. If attention be paid to this remark, and if the gland be at the same time examined from the rectum, little doubt will remain of the nature of the disease.

It is often difficult to draw off the water when the prostate gland has become thus diseased: to do this, much advantage will be found in using a catheter longer than ordinary, as the common curve cannot reach the extremity of the urethra from the increased length of that canal. Pouches or irregularities are also apt to form from the unequal growth of the gland; and as the ducts of the seminal vesicles and mucous glands become enlarged, the instrument ought to be of a large diameter to avoid being entangled by them.

Causes of stricture.

From the idea we have of the manner in which strictures are formed, we infer that many substances of an irritating nature, whether applied immediately to the parts themselves, or to those connected with them, may, under particular circumstances, produce this disease. The stone irritating the bladder, numerous diseases of that organ and prostate gland, irritations in consequence of gonorrhœa, long and repeated erections or other stimulants, and the natural disposition which the urethra has to contract in some constitutions, are the common causes of stricture. In whatever manner irritation is produced, the symptoms and changes observed in the structure of the urethra, make it probable that there is always a certain degree of inflammation subsequent to or accompanying it. Obstructions in the urethra were supposed by Daran, and others about his time, to originate from causes very different from those now mentioned. They conceived that the discharge from gonorrhœa proceeded from internal ulcers, and that the cicatrices and indurations they left behind were the most common causes of stricture. But since the nature of the discharge from gonorrhœa is found very rarely, if ever, to be purulent, and as ulcers occur seldom, they cannot be considered as a common cause of the disease.

Caruncles were also supposed to be frequent causes of obstruction in the urethra; but these are rarely met with. One preparation of such a case may be seen in the museum of St Thomas's Hospital. Indeed, since the internal membrane of the urethra so much resembles that which lines the cavities of the nose, mouth, and œsophagus, and as ulcers in these parts are more disposed to form skin and heal, than to produce fungi, few cases of obstruction can be ascribed to such tumors.

The other causes which prevent the free discharge of urine, are those which are attended with no morbid change in the structure of the urethra itself.

Such are tumors or indurations of the prostate gland, of the vesiculæ seminales, or parts composing the body of the penis, or of the mucous glands along the course of the canal.

By far the most common of these, is an obstruction into the entrance of the bladder, from a diseased prostate gland.

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gland. This proceeds from a new form which the canal has assumed in consequence of an enlargement of its parts. Its cavity becomes deeper from the growth of its sides, and the posterior extremity or valvular process forms a projecting tumor into the cavity of the bladder, which interrupts the passage of the urine, or the entrance of a catheter. From the frequency of this appearance in diseased prostate glands, it is probable that it is the cause of diseases of that organ being often mistaken and treated as strictures of the urethra, and has in numerous instances not only prevented the introduction of a bougie into the bladder, but has been the cause of the formation of artificial passages through the substance of the gland.

Treatment of Stricture.—From the erroneous ideas that the older surgeons formed of the nature of strictures, it was not to be expected that the means of cure they employed were either founded on just principles, or attended with much success. They made use of various external and internal remedies; they prescribed long and tedious courses of mercury, and gave many medicines which were supposed to have peculiar virtues in curing diseases of these organs. They sometimes introduced into the canal mechanical instruments in order to dilate it; and when that was impracticable, a new passage was made by force, or the diseased parts were dissected away, and a new canal formed in the sound parts.

Wiseman's practice.

Wiseman, so far back as the beginning of the last century, exploded many of these rude and dangerous practices, and introduced into use the *waxed candle* or *bougie*, by means of which he said he "crushed the carunculi to pieces." He met with cases, however, where this could not be done; that is to say, cases where it was impracticable to pass small bougies into the bladder; and this led him to adopt another mode of treatment. He consumed them by stimulating applications in the following manner. The wax at one end of the candle was scraped away, and the wick dipped in plasters composed of alum, red precipitate, calcined vitriol, ærugo, and other such substances, and then it was applied to the caruncle. "But (says he), if after doing this you cannot pass the caruncle, you may well conclude it callous; in which case you may pass a canula into the urethra to that caruncle, and whilst you hold that there steady, you may convey a grain of caustic into the canula, and press the caustic to it; and whilst you hold it there, you will perceive its operation by the pressing forward of the caustic. The caruncle thus consumed, cast in a lenient injection daily; and if you take notice of his urine, you may see the separation of the sloughs as rags in it. After which you may with the common medicated candles wear away the remainder, and with the injectious cicatrize it."

The use of caustic proposed by him.

After Wiseman, Daran introduced into use a kind of bougie, the particular composition of which was kept secret. They were supposed to possess very great medical virtues; and it was from these qualities that their superior efficacy was supposed to proceed. Other surgeons soon began to imitate them, and they found that those they made had the same qualities as those of the original inventor. This led them soon after to alter their opinion of their mode of action; and instead of supposing that all the beneficial effects proceeded from the medicines in their composition promoting suppuration, cicatrization, &c. they explained their action on the principle of a simple wedge.

But however successful their practice might have been in alleviating, if not in curing strictures, yet many cases occurred where the obstruction was so complete as altogether to prevent the bougie being introduced. They were therefore obliged to continue forcing past the obstruction, till the mode of treatment described by Wiseman was renewed, and held out as an original invention. The practice, indeed, generally followed by modern surgeons is founded entirely on what Wiseman has written; but since these have been better understood, from the progress of pathological investigation, it has been considerably modified and improved. When we consider the effects of these modes of practice, and try to reconcile them with the ideas we have formed of the causes producing the stricture, it would appear that those very means employed for their removal belong to the same class of bodies with those originally producing the complaint.

Though this cannot be denied, yet it will appear neither surprising nor improbable, when we reason from analogy, and observe the effect of similar applications to other diseased parts, and similar phenomena in other organs. It may here be observed, that the action of any part depends not only on the kind of the stimulus applied, but also on its degree of violence. We know that a slight pressure on the skin produces uneasiness or tickling, whilst in a stronger degree it passes unnoticed. A certain degree of light produces distinct vision, but a more intense one destroys it. The upper part of the throat is thrown into violent action by a slight irritation. Similar phenomena take place in disease; or slight irritations sometimes occasion violent morbid action, whilst those that are more powerful not only produce a lesser degree of disease, but are even employed to remove such as are brought on from a slighter cause. We see this opinion strongly confirmed in ulcers, attended with much local or constitutional irritation. The most emollient applications in such cases, if they do not increase the sufferings of the patient, bring no relief; whilst strong stimulating ones, such as a solution of lunar caustic, or diluted nitrous acid, seldom fail to diminish the pain and promote the cure of the disease*. In toothach, the irritation produced by the external air on the exposed nervous surface excites much pain and even symptomatic fever; but the application of caustic or acid destroys these sensations. The same we will find to take place when we consider the nature and the mode of treating strictures of the urethra; and if we can prove that strictures have all that variety of character which an ulcer or many other diseases have, we will be better able to judge of the comparative merit of the different modes of treatment, and in some degree to account for their mode of action.

* See *Home's Observations on Strictures.*

Of the Bougie.

When surgeons attributed all the beneficial effects of bougies to their mechanical qualities, the principal desideratum was to have them sufficiently pliable to take the

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curvature of the urethra, firm and elastic to make resistance, and mild so as to produce no irritation. But however simple such instruments might be in their composition, yet it will appear that their effect is not the same as that which a wedge produces on inanimate matter. That bougies cannot act by their mechanical powers in removing spasmodic stricture, appears from those cases where the mere introduction of the instrument into the urethra, and its contact with the obstruction, removes at once all spasm.

The same thing is observed in those cases of permanent stricture which are attended with occasional spasm. In such cases it frequently happens that a bougie finds a complete obstruction on its first introduction, but after being allowed to remain for some time in the canal it passes readily without force. A remarkable case of this kind happened, where there was not only a stricture in the urethra, but fistulous openings in the perinæum and scrotum, through which most of the urine was discharged. After much trouble, a very small-sized elastic catheter was passed into the bladder, and as it gave no pain it was allowed constantly to remain. For the first five days the urine flowed through the instrument, but afterwards it began to pass along its sides; and gradually as the urethra dilated, larger instruments were introduced with similar good effect. The silver stiles used by Mr Ware seem to act, in removing obstructions of the lachrymal passages, on the same principle as the catheter in the above example. The stile when first introduced, fills up completely the lachrymal duct; but in a short time the tears begin to flow along the sides, and pass into the cavity of the nose. In these examples it is difficult to explain the action of bougies on mere mechanical principles; it seems much more probable that they produce their good effects, either by a change of action of the living body, or by some alteration in the structure of the diseased parts. Says Hunter, "Pressure produces action of the animal powers, either to adapt the parts to their new position or to recede by ulceration."

Mode of introducing the bougie.

When speaking of the symptoms of stricture, it was observed, that in order to determine with certainty their presence, it was necessary to introduce a bougie. To do this, either with a view of ascertaining the state of the urethra, or in order to remove a stricture, a good deal of caution and nicety is required; for as the urethra is generally tender, painful, and easily thrown into spasmodic action, any awkwardness might entirely prevent the possibility of ascertaining the nature of the complaint, or of affording the means of relief.

When, therefore, the operation is to be performed, in order to discover the kind of obstruction, bougies ought to be provided of different sizes, of a soft consistence, and of a cylindrical form *. One of the size of a common goose quill, or even larger, generally passes easily, and is less apt to meet with obstructions before it comes to the stricture, than one of less diameter. Being of a soft consistence, it readily takes an impression of the stricture, and its blunt point prevents its being entangled by any accidental irregularity.

* See Plate DXIV. fig. 2.

As it ought always to be rubbed over with oil before being used, it generally passes with little more force than its own weight, till it comes to the contracted part, where it stops. After changing with much caution the direction of the point, by elevating or depressing the other extremity of the bougie, and perhaps bringing it a little backwards and then forwards, so as to be satisfied of the situation of the stricture, the instrument may be allowed to remain in close contact with it for a few seconds and receive its impression, so that when it is withdrawn, a precise knowledge is obtained of its situation and form.

Some patients are often so irritable, that any foreign body touching the urethra excites much irritation and pain. In such cases it is the more necessary not to employ the smallest force, and to use an application of opium, or hyoscyamus, to the perinæum, to prevent these inconveniences as far as possible.

When the stricture lies near the extremity of the urethra next the bladder, the point of the bougie ought always to be considerably bent previous to its introduction, so that it may readily accommodate itself to the curve of the urethra; for as a large instrument does not bend easily, it is apt to press on one of the sides of the canal, and give rise to the suspicion of a stricture.

It is also of considerable importance that the point of the instrument be not too conical *. When once we are well acquainted with the state of the parts, such formed instruments may be used with much advantage, as the small point enters the stricture, and by pushing the bougie forward it is dilated by the base of the cone.

* See Plate DXIV. fig. 1.

It may be also here remarked, that in some instances a catheter can be easily introduced when no bougie can pass; we ought therefore to make use of that instrument before finally deciding on the nature of the obstruction (D).

When a stricture is discovered, and when bougies are to be used with a view of curing it, the first thing we are to attempt is to pass one through it. As the bougie we employ is most frequently of a very small size, we must attend particularly to the irregularities in the canal which may entangle the point of a small instrument and the occasional bendings it may make, while it is supposed to be passing forwards towards the bladder. As the mouth of the lacunæ are chiefly situated on the superior part of the canal, the point of the bougie ought to glide along its inferior surface to avoid them.

The bending of the bougie is only to be prevented by a forbearance in using force, and in directing properly the point; but as the common bougies are apt to do this, it is often extremely useful to have catgut ones for this purpose; and it is necessary to have them very small.

In order to overcome the obstruction when the bougie reaches it, the situation of the point ought to be changed by shifting it backwards and forwards, and from side to side, and even employing a little pressure, till it passes forwards, provided the surgeon has a clear and distinct idea of the direction of the urethra.

As the introduction of the bougie almost always brings

(D) The silver balls represented in Plate DXIV. fig. 4. have also been found useful in ascertaining the nature of strictures by Mr Charles Bell.

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brings on spasm to a greater or less degree on the first attempt, it is often necessary to persevere some time before it can be made to pass the stricture; and we must continue in our endeavours a long time before we declare it impracticable.

Leeches and blisters on the perinæum or loins, fomentations of warm water and spirits, turpentine glysters, dipping the feet or glans in cold water, anodyne applications, and the internal use of camphor, opium, or tincture of iron, all assist in alleviating the spasmodic symptoms when they occur, and may be selected for use according to the judgment of the surgeon.

Attention ought to be paid to the composition of the bougie; for those made of elastic metal, catgut, or elastic gum, often give pain, while those made of soft plaster are mild and harmless.

The time which a bougie ought to remain in the urethra, must depend greatly on the peculiarities of the case, for there are no diseases which appear under more various forms than stricture. In most cases bougies can be introduced with little pain, and can remain for some minutes without inconvenience; but there are others where the introduction not only produces general irritation, but the pain is so violent, as hardly to allow them to enter the canal, and sometimes they give rise to constitutional symptoms. In the first case, from the little pain the patient suffers, their use has been abused, and they have been allowed to remain not only when asleep, but they have been worn during the patient's daily employments. It is found, however, that bougies have a more powerful effect when retained for a short time, and often repeated, than when they are longer continued, but seldomer used; so that in no case, however little pain they may produce, ought they to be allowed to remain for a long time. Many indeed think that all their good effects are obtained after they have remained twenty or fifteen minutes, while others allow them to remain for one or more hours.

In cases of stricture accompanied with much irritation, whatever pain the bougie may bring on, it ought not to be thrown aside, but introduced repeatedly whenever there is the least abatement of the symptoms. This practice should be continued for weeks before we despair of success, as afterwards the pain, from daily habit, will be diminished, and the patient will be gradually more and more able to bear it. Whilst we continue the use of the bougie, it ought gradually to be increased in size as the stricture gives way, and be introduced once or perhaps twice a-day till the obstruction is no longer felt, and till the urine flows in a full, even, and natural stream.

When this happens we are not to consider the cure as altogether complete; for it is very generally found, that if the use of the bougie is at this time given up, the parts soon begin to again contract, having still a disposition to return to their former situation, and the disease in a short time is completely renewed. It will therefore be proper to continue using them at distant intervals, some time after the cure appears complete, and give them up in a very slow and gradual manner.

It may be here mentioned, that it is not necessary to retain the point of the bougie in the cavity of the bladder, but merely to allow it to pass the stricture.

Of the Caustic.

In speaking of the use of bougies, we have supposed it practicable to pass one through the stricture; but cases often occur, where, from the tortuous form the canal has assumed, the smallest bougie is prevented from entering the bladder. In such cases, pressure was employed on the diseased parts, in order to destroy the obstruction by producing ulceration; but as this mode was found in many cases to be followed by violent inflammation, and attended with great pain, it was not often performed. Laying open the sinuses, and dissecting out the diseased parts, was also a painful and no less difficult operation, so that no easy mode was ever adopted till Wiseman employed lunar caustic.

From the delicate structure of the urinary canal, it was not without much caution, and in very urgent cases, that this remedy was first employed; but since its action was found not to be violent, it has been freely used by many surgeons, and its application not confined to the more advanced stages of the complaint.

From the time of Wiseman to that of Mr J. Hunter, we find little worthy of remark in surgical writers regarding the use of caustic. The latter of these authors, however, again introduced it into practice, and applied it to all those cases where he could either do no good with bougies, or when he could not pass them through the stricture. In his first trials he met with success; and as he soon improved the mode of its application, he was enabled to employ it with considerable advantage.

Mr Hunter's mode of applying caustic was first adopted by Wiseman; but as the silver canula which he employed, not only gave much pain, but could not, in many instances, be introduced as far down the urethra as a common bougie; and as the caustic could not be applied directly to the centre of the obstruction, a new mode was invented. A piece of caustic was fixed in the extremity of a common bougie, and covered with the plaster except at the extremity, where a part was exposed, but so small as merely to form the apex of the conical point of the bougie. In this manner it is found possible to apply it to almost all cases, and, in dexterous hands, may be used with considerable safety. When it is to be applied to a stricture, it is necessary that some previous knowledge of the case should have been obtained from the introduction of a soft bougie. This done, the armed bougie must be introduced rather quickly, but steadily, till it meets the stricture, which is known both from the feel, and from the situation previously determined. When brought into contact with the stricture, it is perhaps better merely to touch it with the caustic for the two or three first applications, and afterwards it may be retained longer. When the bougie is to be withdrawn, it ought to be done cautiously; for as it has now become soft, and the caustic not so firmly fixed in it, it might fall out, and be left in the urethra. Although this mode has advantages over the silver canula formerly employed, yet there is a way which we think still preferable, as it not only requires less dexterity on the part of the surgeon, but is less apt to do mischief.

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SECT. III. *Stricture of the Rectum.*

As far as we know, there is no author who has given any accurate account of the various morbid affections of the extremity of the rectum. Under the general name of *hæmorrhoids*, a variety of tumors very different from one another have been classed; whilst under the name of *schirrus*, have been considered all cases where the diameter of the lower part of the intestinal canal has been diminished. In a practical point of view, these observations are of the greatest importance, as they lead the surgeon to discriminate between those cases which are likely to be aided by the use of medicines, and those which are beyond the reach of art, or which the same mode of treatment might tend more to aggravate than to alleviate.

In many cases of true schirrus, or cancerous affection of the intestine, the disease first appears by the formation of one or more gristly tumors on the internal surface of the canal; and these by increasing in number and in size, and by involving the adjacent parts, contract the canal, and at last ulcerate, forming true cancerous sores. But there is another class of cases, in which the diameter of the intestines becomes narrowed by a thickening of its coats, and which, were we to reason from analogy, might be compared to that thickening which forms stricture in the other mucous canals, as the œsophagus and urethra. It is cases of this description that we suspect Dessault treated with so much success by the use of bougies *; and from the good effects of this mode of treatment in cases of stricture in other parts, it is reasonable to expect benefit from their use in strictures of the rectum. Dessault, however, wishes it to be understood that the practice is to be employed in the true schirrus; but the two cases which are given in detail by Bichât in his edition of Dessault's works, in illustration of this practice in schirrus, are by no means conclusive. The first is a case of tumors of the internal membrane, which were much alleviated by the compression of a bougie; whilst the second was a case which shows the relief to be obtained by the use of bougies in cases of schirrous contraction in the discharge of the fæces, but by no means in the cure of the disease.

* Oeuvres Chirurgicales.

In cases, therefore, of contraction of the rectum which are not of a schirrous nature, besides the strict attention to keep the bowels regular, and render the fæces as soft as possible by the use of laxatives and emollient injections, bougies made of a proper size may be used with relief; and, as we have mentioned in another place, the practice is also highly serviceable in some cases of tumors which grow from this part of the intestine.

SECT. IV. *Of Polypi.*

Of Polypi.

When any part of a mucous membrane becomes elevated above its natural level, so as to form a circumscribed swelling, the disease is called a *polypus*. That polypi are principally composed of a congeries of arteries and veins ramified through a gelatinous substance, seems probable from their disposition to bleed when injured, and their small size when removed from the living body.

Polypi have been found on all the different mucous surfaces; in the nose, frontal and maxillary sinuses, pharynx, gullet, mouth and gums, meatus externus, conjunctiva, stomach, intestines, rectum, uterus, vagina, bladder, and urethra.

There are four different kinds of polypi, varying from each other in their structure. 1st, The *mucous*; 2d, the *fleshy*; 3d, the *carcinomatous*; and, 4th, the *encysted* polypi.

The *mucous* polypi have a slippery surface, and are constantly covered with a quantity of mucus. They are of a grayish or dull white colour, and have a demitransparent appearance, resembling, particularly at their extremities, a piece of softened glue. They are easily torn and bleed freely; they are neither painful nor sensible to the touch; they suffer remarkable alterations from changes in the state of the atmosphere, extending prodigiously in cold and moist, and contracting in a dry and warm air. They are of an irregular and angular shape, and often seem to take the particular form of the cavity in which they grow. They are commonly attached by a narrow neck, and are quite moveable.

The *fleshy* or carcinomatous polypi are of a bright red colour, their surface is smooth and regular. They are of a rounded form, and are attached by a narrow neck. They are firmer and are not so easily torn, nor do they bleed so readily as those of the mucous kind.

The *carcinomatous* polypi are of a darker red or more purple colour than those of the fleshy kind, and sometimes they are of a livid hue. They are supplied by a great number of blood-vessels, which makes them bleed profusely even when slightly injured, or gives them a disposition to bleed of themselves. They are of a very firm structure; some of them being as hard as cartilage. They are more or less painful, and are very sensible to the touch. Sometimes the pain is of that stinging lancinating kind which carcinomatous tumors have in other parts of the body. Their surface sometimes ulcerates, and the ulcer assumes all the characters of a cancerous sore. They are commonly attached by a firm broad basis.

The *encysted* polypi occur least frequently. Richter says that they resemble a reticular sac, which contains fluid sometimes resembling mucus; at other times it is of a thick consistence. In one case we found the mucous membrane covering the superior spongy bones extended, but not much thickened; and between its folds there were several round semitransparent vesicles, containing a thick glairy fluid.

SECT. V. *Of Polypi of the Nose.*

All the four different kinds of polypi have been found growing from the mucous membrane lining the cavity of the nose; we have also seen the superior spongy bone so increased in bulk, as to form a tumor resembling the fleshy polypus.

The first symptom of a polypus in the nose is a preternatural degree of redness of its mucous surface. It becomes spongy and callous, and there is an increased secretion of mucus. The patient has some interruption in breathing, and the voice is rendered more or less indistinct; he feels as if stifled, and he tries to get quit of

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of something which incommodes him by blowing his nose; for the same reason as a person does who labours under a common catarrh. The sense of smell becomes impaired, and all these symptoms are more troublesome in wet than in dry weather.

The symptoms increase till the extension of the mucous membrane increases to such a degree, as to form a distinct circumscribed tumor; and the progress of the complaint is generally so slow, that its nature is frequently not suspected till it gets this length.

By degrees the breathing through the nose and the sense of smell are entirely destroyed from the mechanical obstruction of the tumor; and the patient himself finds, that by a violent expiration or inspiration, the tumor can be pushed forward or backward in the nose.

The pressure which a *polypus* sometimes makes on the nasal duct prevents the tears from flowing freely into the nose, and is the cause of a watery eye.

When the tumor is large, the septum of the nose is frequently pressed, and pushed to the opposite side, and then the respiration is oppressed in both nostrils. Sometimes the tumor descends, and part of it projects through the nostril; when this takes place, the surface of the part exposed to the air becomes like common skin. This indeed happens when any mucous surface is exposed. We have observed it in the vagina when inverted, and in the eyelid when the palpebral membrane was turned outwards, from a tumor, or any other cause.

Morgagni takes particular notice that the natural position of the septum is apt to be mistaken for disease, as it frequently divides the nasal cavity into two unequal portions.

More frequently polypi extend backward into the pharynx, and can be felt by introducing the finger behind the velum pendulum palati. In one rare instance, we have known a polypus so large, as to descend along the œsophagus into the stomach, and in another to fill up the whole cavity of the mouth and produce suffocation.

It happens also that polypi growing from an extensive base, separate, displace, and produce an absorption of the bones which surround them. The bones of the nose are pushed upward; the maxillary bones and the palate bones are disjoined, and carried outward; the arch of the palate depressed; the inferior margins of the orbits are pressed upward, and push the eyes out of their orbits.

Polypi arise from every part of the nasal cavity; but most frequently from the spongy bones. Many surgeons have conceived that polypi arose from general diseases of the constitution, as scrofula, syphilis, &c.; but it will in general be found to be a mere local disease, and probably arising from whatever tends to produce a continued or repeated attack of inflammation in the part.

Treatment.—If polypi are attached to the upper spongy bones, their removal will be more dangerous, as the inflammation excited by an operation will be reapily conveyed to the brain. When they are attached to the inferior spongy bones, they can be removed with perfect safety.

The most celebrated surgeons have never advised any operation when the tumor is small and gives no distress; but whenever it becomes of such a size as to fill up the cavity of the nostril, disturb respiration, and assume a malign aspect, it ought to be removed.

As long as polypi continue small, or when the mucous membrane acquires that appearance which indicates the commencement of the disease, tonic and astringent remedies are generally recommended; as a decoction of oak bark with alum; strong solutions of white vitriol, saccharum saturni, or muriate of mercury, ardent spirits, and vinegar. Either of these solutions, which may be selected, ought to be thrown up a little warm into the nasal cavity with a syringe, retained there half a minute or more, and repeated four or five times daily; or a piece of charpee wet with them may be put into the nose with a probe, and applied to the deceased surface. Kino, galls, white vitriol, &c. sabine in the form of powder, snuffed up into the nose, as strong as the patient can suffer it, are also useful in stopping the progress of the disease. Mercury has been found rather to make them worse; caustic and other corroding applications have been of use in the softer kind, though they have never produced a cure. Bougies have been recommended by Mr B. Bell, and are said to have been useful; and when the polypus is small, they may act on the same principle as bougies do on tumors of the rectum, a practice so successful in the hands of Dessault.

Polypi may be removed either by tying a ligature round their neck, by tearing or twisting them, or by cutting them out with a knife or scissars.

Operation.—Professor Richter of Gottingen, and several eminent practitioners of this country, use, in general, the forceps; and in those cases where the polypus is attached to the inferior spongy bones, or to any of the inferior parts of the nasal cavity, this mode of operation is much more easily performed, and has the best chance of success. From the soft texture of the superior spongy and ethmoid bones, with which they are connected, there is a considerable risk of tearing and injuring more parts than is necessary for the removal of the polypus; and, as any inflammation excited on these may spread to the membranes of the brain, it is more adviseable to remove polypi attached to these parts by the ligature.

When polypi are completely within the reach of the knife, adhering towards the external opening of the nostrils, they may be easily cut away.

In performing any operation, or even making an examination of the state of the nose, it is of considerable importance to attend to the position of the forehead, and to employ a proper light.

The head should be bent backwards; and in order to enlarge the external nostril, an assistant, on whose breast the head of the patient rests, ought, with the fore-finger of his right hand, to press upward the point of the nose: whilst, with a probe in his left, he spreads out the alæ.

Of removing Polypi with the Forceps.—Forceps for this purpose ought to be six inches or six inches and a half long, and the axis at two-thirds of their length distant from the extremity of the handle; so that the operator may have the advantage of a long lever. See Fig. 1. Plate DXV.

Plate DXV. fig. 1.

The points of them ought to be blunt, rounded on the outside, perforated, and a concavity, made rough, extending

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extending to near the axis. The two blades ought to be separated at their union, when closed, and not to become parallel till they are opened to a considerable distance, in order that the polypus may be held very firmly. The blades should be strong, and pretty broad.

Even this form of forceps is not always sufficient; and it is useful to have a pair of such as has been recommended by Richter *. They are intended to be employed in those cases, where the polypus is so large as completely to fill the nostril, and so hard, that the upper part of the blades of the common forceps cannot sufficiently dilate to allow their extremity to pass down the nostril, and reach the bottom or neck of the tumour.

* See Plate DXV. fig. 2.

It is of great importance to fix the forceps as near the root of the polypus as possible; for, when that is accomplished, the whole mass may be at once removed: and the hæmorrhagy is never so great as if the polypus was torn through the middle.

Often, however, it happens, that the polypus is so large as to distend the nostrils in such a manner, that it is impossible to discover the root till the extremity is removed. We must, in such a case, remove as much as we are able, and even although the bleeding is profuse, persevere in the operation as long as we can pull any away with safety.

When the operation is to be performed, the patient ought, by his own efforts, to push the body as far forwards as possible; then the surgeon, with a pair of small forceps in his left hand, seizes the point of the polypus, and having kept fast hold of it, he cautiously introduces the polypus forceps on the outside of the others. The more time that is bestowed on this step of the operation, the more the polypus becomes elongated and thinner, the more room is given for the forceps, and therefore the higher up can the polypus be grasped. After it is completely secured between the blades of the forceps, it is to be twisted slowly round, and at the same time pulled outwards. If only a portion of the polypus is removed, what remains is to be extracted in the same manner. The hæmorrhagy is generally profuse, but seldom requires the assistance of art to stop it.

Of Removing Polypi by the Ligature.—The ligatures consist of wire, catgut, silk or cord; and different methods have been employed for passing them round the root of the polypus. In order to remove a polypus, the anterior part of which is situated in one of the nostrils, a ligature (*a*) † is to be introduced through a double canula (*b*), and one end fixed round the ring (*c*); whilst the other end (*d*) being loose, allows the noose at *a*, to be increased or diminished, according to the size of the polypus. The polypus is to be grasped by a pair of forceps put through the noose, and drawn forwards. The ligature is then to be carried to the root of the polypus, either by means of the forked probe (fig. 4.), or by one of the porte-nœuds (fig. 5.), taking care to tighten the wire gradually, the further the instrument is introduced. When the noose reaches the root of the polypus, the ligature is to be firmly drawn, and secured by being twisted round the ring of the canula. If the polypus hang down behind the velum pendulum palati, the doubled wire is to be slowly insinuated through the nostril into the throat. The finger of the surgeon is to be introduced into the mouth, and by opening its doubling the noose passed over the extremity of the polypus, and conducted to its root, by gradually tightening the ligature, and then it is to be firmly fixed. The ligature should be tightened once or twice a-day, until the tumor entirely separates. As there is generally a considerable degree of swelling and inflammation of the tumor before this takes place, if it be so situated as to disturb respiration, it may even be necessary to perform bronchotomy as a preliminary step. Should any part of the polypus remain, it may be destroyed by caustic, or the actual cautery, if practicable.

† Plate. DXV. fig. 3.

Besides this, which is the common and most simple mode of applying the ligatures, there are others which are well adapted for particular cases. The apparatus employed by Dessault is extremely ingenious and well-suited for its purpose, but is more particularly useful in polypi of the vagina and uterus.

Dessault's apparatus.

When this apparatus is to be used, two porte-nœuds (*a a*) ought to be procured, and having pushed the cylinder over the branches of the stalk, so as to shut the rings (*d*) completely, a ligature of waxed thread, catgut, or silver wire, is to be passed through them (*k*), and the extremities may be either held along with the canula or secured at *e* *.

The two canulas, thus armed, are introduced parallel to one another between the tumor and parietes of the cavity in which it lies; and when they reach its base, one is held firm, and the other carried round the base, crossed over the other, forming a noose round it.

* See Plate DXV. fig. 5.

The ligature being pulled tight by an assistant, the two ends are to be put through the hole (*g*) of the other canula, and fixed to the axis at *h*.

The extremity (*g*) is then to be slipt along the ligature close to the polypus; and the ligature being firmly fixed to the other extremity, the two porte-nœuds may be at once removed, by allowing the ring to divide and the ligature to escape.

This being done, nothing remains to complete the operation. The ligature is kept round the polypus till it drops off, and as the parts begin to give way, it ought to be retained always perfectly tight; and this may be easily accomplished by turning the screw at *h*.

The apparatus, too, (fig. 6. Plate DXV.) may also be sometimes useful, from the flexibility of the canula, which conveys and directs the ligature.

2. *Of the Polypus of the Rectum.*

Polypi of the rectum differ considerably from the common *hæmorrhoidal* tumor, in their symptoms and appearances. They resemble the fleshy polypi in other parts of the body, in their colour and external form, and they are also sometimes ulcerated on the surface. On cutting through a large tumor of this kind, we found it composed of a vast number of cells, some of them very large, and all of them filled with blood. Their progress is slow, and we have seen them grow as big as a large walnut. They do not alter their size at different times, as is observed of the hæmorrhoidal tumor, except, that they are apt to swell, when allowed to remain long external to the anus. They are most commonly situated in the rectum, close to the anus; so that when the patient goes to stool they are pushed downwards,

Of Polypi.

downwards, and appear externally. When very large, they are also apt to come through the anus by the least exertion in walking. They are generally attended with more or less pain or uneasiness on going to stool; and when they become so large as to come through the anus in walking, the disease becomes very distressing. They are often accompanied with a discharge of mucus. Sometimes, too, hæmorrhoidal tumors are formed contiguous to the polypus; but the latter is generally pointed out by the patient as the original swelling, and that which gives most pain. These tumors may also be readily distinguished from one another by their difference in colour and form.

Treatment—Astringents, with opium, and bougies, may alleviate the symptoms; but as they seldom give permanent relief, the most complete and safest mode of cure is removing them with the knife, if they can be readily reached; if not, the ligature is preferable, although it gives much more pain; for it sometimes happens, that a very profuse bleeding follows after they have been cut away. The hæmorrhoidal tumors which accompany the polypus disappear after its removal.

When they are tied with a ligature, this can be done in most cases by simply tying a strong silk thread firmly round the base of the tumor. Often the base is larger than the apex, and then it is necessary to pass through the middle of the tumor a curved needle with two ligatures, one to tie each half of it. To prevent any mistake, and accelerate the operation, surgeons make one of the ligatures of black, and the other of white thread. Whilst the mortified part is separating, great attention is necessary to keep the surrounding parts from excoriating; and this is to be done by frequently washing with warm water, or a saturnine solution, and anointing them with saturnine ointments, or the unguentum resinosum. Fig. 7. Plate DXV. gives an outline of tumors of this kind.

3. *Polypi of the Gums*

Most frequently are connected with caries of a tooth, or of the alveolar processes of the jaw bone; sometimes, however, not. They are generally of a firm fleshy texture, rounded form, polished surface, and are very apt to bleed; and they sometimes grow to a very large size, and become malignant. They are best removed by the knife; and, as they bleed profusely, it is often necessary to use the actual cautery to restrain it. If the bone be found carious, the diseased part should, if possible, be removed, or means used to assist and promote its exfoliation; and when this has taken place the polypus often disappears without any operation.

4. *Polypus of the Frontal Sinus.*

This is a very rare disease, and it produces the same dreadful consequences as that of the antrum. Art can perhaps venture to do little, as the close connection to the brain would render any attempt to remove it dangerous.

5. *Polypus of the Antrum Maxillare.*

The surgeon is seldom aware of the presence of this disease until it is far advanced, and has begun to distend the bony cavity in which it is formed. It sometimes acquires a prodigious bulk, separating and rendering carious the bones of the face, pushing the eyeball out of the orbit, and filling up the cavity of the mouth. If the nature of the complaint is early suspected, by removing a portion of the external parietes of the antrum with a trephine, the polypus may perhaps be removed from its attachments; but if that is impracticable, strong astringent applications, caustic or the actual cautery, or removing portions by the knife, may arrest the progress of the disease.

Of Polypi.

6. *Polypi of the Urethra.*

These are what have been called caruncles, and were supposed to be the most common cause of stricture. It is now, however, well known that they occur seldom. If their growth is not checked by the use of a bougie, and if they are not near the meatus urinarius, it may be necessary in some cases to cut in upon the urethra, in order to get them extirpated; but that must happen rarely.

7. *Polypi of the Bladder*

Are beyond the reach of the surgeon, but they occur very rarely; and the distressing symptoms which attend this disease, can only be alleviated by those internal medicines which dilute the urine and allay the irritability of the bladder.

8. *Polypi of the Ear.*

They sometimes grow from the membrana tympani, but they generally arise from the cavity of the tympanum, after the membrana tympani has been destroyed by ulceration. They resemble the common mucous polypi in structure; and they are most frequently accompanied by a discharge of puriform matter and a total loss of hearing. They may be removed with a ligature in most cases very easily; or they may be torn out with forceps; and it is always necessary to touch the part to which they adhered repeatedly with caustic, and to use strong astringent washes, in order to prevent their future growth.

9. *Polypus of the Conjunctiva.*

We have never observed them on the sclerotic conjunctiva; but they are formed on the inner membrane of the eyelids, and most frequently on the upper one. They are soft pendulous masses, which, being loose, float between the eyelids and ball, and sometimes even pass beyond the edge of the lids. They are of the red colour of the inflamed mucous membrane; but those portions which are exposed to the external atmosphere become dry, and often drop off. They are often formed in consequence of the membrane being inflamed by an abscess bursting internally. They are easily removed by the knife; and they are prevented from being regenerated, by slight scarifications or the application of lunar caustic to the base.

10. *Of the Polypus of the Uterus.*

These polypi are found to grow either from the fundus, the lower edge of the os uteri, or from the inside of the cervix. The first is the most, and the second the least frequent. The shape of the uterine polypi is generally pyriform, having a very narrow neck. They are commonly of the sarcomatous kind; though it often happens that polypi are formed in uteri affected with cancer.

Of Aphthæ.

cancer. Polypi protruding into the vagina are apt to be mistaken for prolapsed uteri; and this mistake is more likely to take place in some cases where the polypus acquires a large bulk in the uterus, and is suddenly protruded into the vagina, and strangulated by the os tincæ. Cases, too, of prolapsed uteri have been mistaken for, and treated as polypi.

The safest mode of removing uterine polypi is with the ligature. When it is situated in the uterus, this operation is impracticable; but when it descends into the vagina, it may be very readily done by the apparatus of Dessault (Plate DXV. fig. 5.).

Sect. VI. *Of Aphthæ.*

The formation of aphthæ, when they are examined with care in their different degrees, may probably extend our views of the intimate structure of the mucous membranes. Boerhaave considered them as small superficial ulcerations, and Stahl regarded them as tubercles or pustules. From the present state of our knowledge it is difficult to determine whether aphthæ originate in the chorion of the mucous membrane, in its papillæ, or in its mucous follicles.

Aphthæ are formed on the lips, the gums, the interior of the mouth, the tongue, the palate, the amygdalæ, the œsophagus, and also in the stomach and intestines. They are most frequent in children and old people, and they have been observed in people who inhabit places where the air is tainted, and who live on unwholesome food.

The aphthæ of the adult may be considered as a collection, more or less agglomerated or insulated, of white superficial rounded tubercles, each about the size of a millet seed. These tubercles discharge a serous humour; the pellicle which covers the mucous membrane is detached, and is progressively formed in the different parts of the mouth, and even in the rest of the alimentary canal. They are sometimes disseminated in solitary pustules over the tongue, the angles of the lips, or the back part of the mouth, with a benign character. At other times they are formed and seemingly propagated from the interior of the œsophagus; pass the back part of the mouth, forming a white, thick, and strongly adhering crust; and these are often dangerous from a complication of typhus fever.

Aphthous tubercles vary in colour. Sometimes they are transparent; at other times they are white, with a certain degree of thickness; they are also sometimes of a deep yellow colour, and sometimes they are livid or blackish, a symptom which always indicates a greater degree of danger.

Aphthæ may also be frequently observed in people who have taken many courses of mercury. In these cases, the repeated action of the mercury on the mouth appears to leave on that organ a degree of sensibility or weakness which disposes it to the disease. It happens not unfrequently that aphthæ are considered as venereal sores, in consequence of the venereal disease not having been properly cured; on this supposition a new mercurial course is employed, which only augments the disposition to aphthæ, and makes the sores spread more rapidly.

The aphthæ of children are preceded by a profound sleep, by agitation of the muscles of the face and lips, difficulty of respiration, prostration of strength, feebleness of the pulse, and vomiting. In the mild form of the disease, white superficial spots appear in different parts of the mouth, which are separated from one another, and the interstices are neither red nor inflamed. The bottom of the mouth has often been discoloured, and the heat immoderate; there is no difficulty in swallowing, and the child can readily suckle; the sleep is natural, and there is a slight diarrhœa. The spots during the first days preserve their whiteness and transparency; they afterwards become a little yellow, exfoliate in flakes, and go away entirely about the ninth or tenth day, particularly when the child has a nurse.

Of Hæmorrhagy from Mucous Membranes.

The confluent or gangrenous aphthæ have other characters. The small pustules are contiguous to one another, and spread not only over the lips, the gums, the tongue, and the anterior of the cheek; but we also see them at the bottom of the throat. The mouth of the child is burning; the lips are with difficulty applied to the nipple, and sometimes it is excoriated by their contact. Deglutition is very difficult, and the most simple drinks given in small quantities, and with precaution, do not enter into the stomach but with pain. There is a constant purging of greenish matter, which inflames and excoriates the skin round the anus; the child is very feeble and heavy, the eyes are sunk and shut, and the child screams. The whole interior of the mouth from the lips to the throat becomes at last lined with a white thick crust, resembling coagulated milk. This crust becomes yellow, and forms a slough, which, after it falls off, exposes gangrenous ulcers of a dark brownish yellow colour.

Treatment.—In the benign form of the disease in children, it is of great consequence to get the child a good nurse; and the affected parts may be washed over five or six times a-day with a piece of caddis dipped in a little water gruel, to which has been added a few drops of sulphuric acid. Borax, either in powder or solution, has also been considered by some as a useful application. When the crust has separated, if the remaining ulcer be painful and irritable, its surface may be rubbed over with nitrate of silver, or any other caustic application. Sometimes very malignant looking ulcers remain in the adult, after the separation of the crust. In these cases, caustic may be employed; and we have often seen them heal rapidly by touching their surfaces once a-day with a weak solution of corrosive sublimate or muriatic acid. For the treatment of the confluent aphthæ, see MEDICINE.

Sect. VII. *General remarks on Hæmorrhagy from Mucous Membranes.*

All the mucous surfaces are particularly subject to hæmorrhagy; and this may arise either from a rupture of the vessels, or the blood may be poured out by the exhalents.

The superficial position of the vessels, and consequently their want of firmness and support, exposes them much to rupture by very slight concussions. We have examples of this in the bronchiæ, brought on by coughing; in the nose, by slight blows on the head, or by violent sneezing; and in the rectum, by straining on going to stool. The effect of stones or gravel on the mucous membrane lining the urinary organs is the same; and even

Hæmorrhagy from Mucous Membranes.

even the most cautious introduction of a sound or bougie into the urethra, often causes bleeding; or the slightest friction of polypi of the nose and gums, or the introduction of a probe into the lachrymal passages. When considering the diseases of the skin, we mentioned, that in some diseases, particularly some pestilential fevers, the exhalents of the skin poured out red blood. The same thing happens among the mucous membranes. We often see blood come from the nose, from the bronchiæ, stomach, and intestines, urinary bladder and kidneys, where there has been no reason to suppose ulceration previously to have taken place, or any thing to cause a rupture of any of the vessels. In one case a young woman bled from all the mucous surfaces.

1. *Hæmorrhagy from the Nose.*

Hæmorrhagy from the nose arises from a variety of causes. We often observe this after fevers, and then it has been considered as critical. In young people it occurs very frequently, and from very slight causes; and it has been sometimes known to take place at the menstrual period.

Hæmorrhagy from the nose is generally preceded by symptoms of an increased quantity of blood to the head, pulsating motion of the temporal arteries, feeling of weight about the head, symptoms which are preceded or accompanied by other changes in more distant parts; such as spontaneous lassitude, pains about the belly.

When the means mentioned for this complaint in the article MEDICINE have failed, recourse must be had to compression. Dossils of lint introduced into the nostrils are sometimes effectual; or the gut of some small animal, tied at one end, then introduced by a probe into the nose as far as the pharynx, and filled with cold water, or water and vinegar, and secured by a ligature, by adapting itself to all the parts, and pressing equally on them, has been attended with advantage. When these remedies likewise fail in their effect, a piece of catgut or wire may be introduced through the nose into the throat, and brought out at the mouth; a piece of sponge, or a bolster of lint of a size sufficient to fill the back-part of the nostril, is then to be fixed to it; the sponge is next to be drawn back and properly applied. Another is to be applied to the anterior part of the nostril and secured. The same may be done to the other nostril, if it be necessary; or the sponge may be of such a size as to fill the ends of both nostrils at the same time. By this contrivance the blood not finding an outlet, will soon coagulate, and prevent any farther evacuation.

2. *Hæmorrhagy from the Rectum*, or *Fluxus Hæmorrhoidalis.*

The discharge of blood from the rectum is a disease chiefly confined to those advanced in life. It is often occasioned by full living, change from an active to a very sedentary life, the abuse of purgatives, particularly aloes; violent passions, or habitual melancholy. The symptoms which precede and accompany this disease, are bearing down pains, and a sensation of weight in the back and loins, sometimes a numbness in the limbs, and a contracted pulse, thirst, diminution of urine, flatulency, and sometimes a discharge by stool of a white mucus. The discharge returns commonly in a periodical manner once a month, and thus becomes necessary for the preservation of health; for if it be suppressed, or if it stops spontaneously, it occasions a variety of nervous affections, such as spasmodic tightnings about the chest, colic and vertigo.

Of Hæmorrhagy from Mucous Membranes.

Treatment.—When the hæmorrhoidal flux has become habitual like the menstrual discharge, we not only ought not to attempt curing it, but if it be from any cause suppressed, it ought to be restored. If it be the effect of general plethora, it is to be removed by a vegetable diet and moderate exercise. In order to moderate the discharge, the patient ought to lie in the horizontal posture on a hard bed, avoid all exercise, keep the belly open by cooling laxatives, or even to take acids if the bleeding is excessive, and apply cold to the loins and perinæum. As a sudden suppression of the hæmorrhoidal discharge is the cause of many diseases, it is sometimes of much importance to reproduce it. To effect this, leeches and warm fomentations applied to the anus, are the most efficacious remedies.

3. *Hæmorrhagy from the Bladder* (Hematuria).

Hæmorrhagy from the bladder is a disease most frequent in old people; it is often occasioned by a suppression of the hæmorrhoidal discharge, or any other accustomed discharge of blood. It is sometimes the consequence of excess in living and drinking, and of a sedentary life followed by great exercise. It also arises from a plethoric state of the system, violent exercise on horseback, the internal use of cantharides, a contusion in the region of the kidneys, or from stone in the bladder.

Treatment.—The treatment to be employed is the same as in hæmorrhagy in general. Every thing ought to be avoided which might tend to irritate the kidneys or the urinary bladder. Laxatives, acid drinks, the application of ice to the lumbar region, hypogastrium, and perinæum, or to the inside of the thighs, is of great importance. Under the articles MEDICINE and MIDWIFERY, we have considered the hæmorrhagies from the lungs and uterus. We may here remark the connection and strong sympathy which subsists between these organs, and also between them and the other organs of the body; for a minute acquaintance with these may often lead to a successful mode of treating their diseases. When the menses are suppressed, there is often a hæmorrhagy from the mucous membrane of the lungs; and there are also many cases of obstruction in the bowels which bring on hæmorrhagy both from the lungs and uterus; a hæmorrhagy which never ceases until the primary affection be removed.

SECT. VIII. *General Remarks on the Ulceration of Mucous Membranes.*

Simple inflammation of a mucous surface seldom, if ever, terminates in ulceration, most ulcers of these parts having a specific character. The venereal inflammation rapidly terminates in ulceration; and aphthæ have the same tendency, forming often what are called phagadenic sores.

The mucous membrane of the nose is peculiarly subject to ulceration; ulcers also occur in the different parts of the mouth and gums, in the pharynx, larynx, œsophagus, in the intestinal canal, and also, though

very

Of the Diseases of Serous Membranes.

very seldom, in the urethra. It is the first of these only which are to be treated of in this place.

Of Ulcers of the Nose, or Ozæna.

This species of ulcer sometimes appears in the nostrils, and sometimes in the frontal or maxillary sinus. It generally succeeds a violent coryza. It also sometimes arises from blows on the nose, or from the application of very acrid substances. Ozæna is often accompanied with inflammation, hæmorrhagy, pains, caries of the bones which sometimes destroys the palate bones, cartilages of the nostrils; and by hindering more or less the free passage of the air, it alters the tone of the voice.

Treatment.—In the simple ozæna, much benefit generally arises from the use of astringent washes, such as a decoction of oak-bark and alum, solutions of sulphate or acetate of zinc, or the acetate of lead. The best mode of using these is to inject them a little warmed, with a common syringe, into the affected nostril, three or four times a day; and when the quantity of discharge diminishes and becomes of a better quality, an ointment composed of the flowers of zinc or the like, spread on a piece of lint, should be introduced once or twice a day into the nostril.

When the ozæna is of a more virulent nature, and the bones affected with caries, there is generally great reason to suspect a venereal taint. This can only be determined by the history of the complaint and the constitutional symptoms of the venereal disease being present. In such cases mercury is the only remedy, and along with its internal use the injection of mercurial lotions, and the use of fumigations, will be serviceable. In such ulcers as are obstinate, and which do not partake of any venereal taint, a liniment, with an eighth part of the red precipitate of mercury, or a smaller proportion of the acetate of copper, has been recommended by Mr Bell as an useful application. In some cases too, where, after the venereal taint is destroyed by a proper mercurial course, there remains an obstinate sore, the above liniment may be useful, and a course of sarsaparilla or cinchona has also been found in such cases of much advantage.

Chap. IV.

Of the Diseases of Serous Membranes.

General Remarks on the Pathology of Serous Membranes.

The phenomena of the diseases of serous membranes are very different from any of those of the other textures which have been mentioned. When they are attacked with inflammation, the serous surfaces often adhere together, or if suppuration takes place, it is never accompanied with ulceration or erosion of their substance. However abundant these purulent collections may be, the membranes always remain sound, with only a little additional thickness; the purulent fluid rejected from them, being like the natural fluid formed by exhalation.

The serous cavities are also subject to hæmorrhagy, and to preternatural collections of the exhaled fluid.

Under the article Medicine we have treated of inflammation of the pleura, membranes of the brain and peritoneum, and also of hæmorrhagy from these organs. In this place we shall consider dropsy and hæmorrhagy from the vaginal coat of the testes, as the only diseases belonging to surgery.

Of Ascites.

Sect. I. *Dropsy of the Peritoneum, or Ascites.*

When water collects in a considerable quantity within the cavity of the peritoneum, the skin becomes dry and scurfy, and the superficial veins varicose. In one case they appeared like large tubes half filled with blood, the anterior part of the canal thin and dry, and the posterior portion hard and unyielding. The skin at the umbilicus is sometimes much distended, and the water seen shining through it as in a common blister. The water varies much in its appearance; most frequently it is yellow or brownish. We have seen it as thick and dark coloured as coffee grounds. In one case it was viscid and tenacious, resembling the white of an egg; and in other instances it resembled milk and water, with the milk partly curdled. Ascites is generally accompanied with a disease of some of the abdominal viscera, and most frequently the liver.

It is not confined to any particular period of life, but has been observed more frequently in men than in women.

The symptoms of ascites are, 1. The swelling and sense of tightness over the belly. 2. Laborious and difficult breathing, especially in the horizontal posture. 3. The distinct feeling of fluctuation, upon applying one hand to one side of the belly, and striking it with the other hand on the opposite side. 4. The urine is in small quantity, and of a dark red colour. There is also thirst, a dry skin, often a feeling of heat, and very frequently œdema of the inferior extremities.

Operation.

Paracentesis.—When the swelling becomes large, and internal medicines have no effect in diminishing it, it is adviseable to discharge the water by an artificial opening, an operation which seldom cures the disease, but is always attended with temporary relief, and may be repeated as often as the water is found to collect. Smucker has performed it seventy times, and protracted the patient's life for many years. The operation is to be performed by introducing a trocar* at the linea alba, as used in hydrocele, about two or three inches below the umbilicus. Many surgeons now prefer this place, as it prevents all risk of wounding the epigastric artery, or any other important part. It was formerly the common practice to introduce the instrument on the left side of the abdomen, half way between the umbilicus and anterior superior spinous process of the ileum, in order to avoid the liver and epigastric artery. But those who laid down this rule were not aware of the change in the relative situation of parts when diseased; and it has several times happened to Mr Cline as well as other eminent surgeons, in performing the operation at this place, that they have wounded the epigastric artery, and the patient has died of hæmorrhage. The dissection of the abdominal muscles in patients who have died of dropsy, shows how much the *recti* are extended in breadth, and the situation of the epigastric arteries changed.

* See Plate DXIV.

The place for entering the trocar being determined, and marked with ink, the patient should be placed in the horizontal posture, and in such a situation that the water

Of Hydrocele.

water can be run off readily into a vessel proper to receive it. But as patients are very apt to faint if the water is suddenly removed, and no pressure applied to support the belly as it is emptied, it is necessary to make an equal pressure during, and after the operation. From neglecting this in some cases, dangerous symptoms have arisen, and in one instance the patient died three days after the operation from this cause. A piece of flannel as broad as the belly, and divided into several pieces at each end, and these drawn across each other by assistants, or the bandage *, answers for this purpose. By either of these the belly may be gradually compressed as the water is let out, and the compression continued for several days after the operation. Sometimes the water does not come out readily, a portion of omentum or intestine coming in contact with the end of the canula; but the discharge may be assisted by introducing within the canula a blunt probe, or a less canula within the first, having small perforations at the extremity and edges. After all the water is discharged, a piece of plaster should be applied to the wound, and every care taken to exclude the external air. The bandage should also be kept applied, and it may be worn for some time.

* Plate DXIV.

Sect. II. *Water collected in the cavity of the Vaginal Coat, or Hydrocele.*

The effusion of water in the tunica vaginalis, frequently accompanies hernia, the scrophulous schirrus, venereal and other enlargements of the testicle; but in such cases, it is merely to be considered as a symptom accompanying these disorders. Sir Everard Home mentions cases where it was a symptom of stricture. It occurs also during the abatement of inflammation of the testicle; and sometimes more or less of the water remains after the inflammatory symptoms have disappeared. In cases of this kind the tunica vaginalis is generally found thickened, and there is an effusion of lymph over its surface as well as over the surface of the albuginea. In many cases, the water is collected where there is no apparent alteration in the structure of the parts. The disease in such cases most probably arises either from a diminished absorption or from an increased exhalation. If the disease has been of long duration, the tunica vaginalis is generally thickened, and sometimes to a great degree; and particularly in old people it becomes hard or cartilaginous. We have seen preparations where it was converted into a shell of bone. In two cases a round substance resembling cartilage was found floating in the water of a hydrocele. It is not uncommon to find the vessels also of the spermatic veins more or less varicose. Collections of water of considerable size, form sometimes after birth (*wind rupture*); but in old people they are most frequent. The water is usually collected only in one cavity; but it sometimes happens, that in consequence of adhesions between the tunica vaginalis and albuginea, several irregular shaped bags are formed in which it is contained. The water usually collects in one side of the scrotum, but sometimes in both. The water is generally clear and straw-coloured, sometimes it is coloured with blood, sometimes yellow or brown, and sometimes thick, and like coffee grounds. See Morgagni, Ep. xxxviii.

The quantity of water varies. In the Act. Erud. Lipsiensis 1725. p. 492, there is mention made of a case which contained forty pounds of fluid. Doight saw one which contained four pounds. There are sometimes also hydatids found along with the water. Richter has met with four cases of this kind.

Symptoms.—1. The scrotum is commonly of a pyramidal form, and the corrugations of the external skin are destroyed in proportion to the bulk of the swelling. The shape of the tumor however varies; in some cases, it is very globular, and in others it appears like two swellings joined. It is even altered from the manner in which it is suspended; if a bag truss has been worn it is usually oblong. 2. The swelling generally begins at the lower part of the scrotum, and as its bulk increases, it gradually ascends towards the abdominal ring. 3. It appears pellucid when held between the eye and a candle; but this is not a certain prognostic, as the transparency is destroyed when the tunica vaginalis is thick and hard, or when the water is turbid and dark. 4. It gives the distinct sensation of fluctuation. In some cases, however, the degree of thickening of the tunica vaginalis renders the fluctuation obscure or imperceptible, and also destroys its transparency. 5. The tumor cannot be made to recede or change its situation from pressure or change of posture of the body. 6. The testicle is involved in the swelling, and can be distinguished like a firm unyielding mass usually at the posterior part of it. In cases where adhesions have been formed, the position varies; but the patient generally knows where it lies, and pressure applied to the part of the swelling where it is situated gives pain. Sometimes the testicle is placed at the under part of the swelling, sometimes in the middle. Mr Bell felt it twice forwards. Sometimes along with the water there are hydatids floating in the cavity of the vaginal coat. Somering says, that he has often observed this appearance. 7. The spermatic chord can be readily distinguished unaltered. 8. The tumor gives little or no pain, and the patient suffers merely from its bulk. 9. The growth of the swelling is generally very slow, and sometimes years elapse before it becomes a great inconvenience; sometimes, however, it forms rapidly. When it grows very large, the integuments become think, and the veins varicose; if the swelling extends up to the inguinal ring, the cord cannot be felt, and the penis is sometimes so much involved in the tumor, that it appears like an umbilicus or piece of corrugated skin.

Treatment.—In children, the water generally disappears in a short time, by the application of strong astringent or discutient applications. In some cases, the disease advances so slowly, that it is sufficient to wear a suspensory bandage. Richter mentions a case where it was twenty years old before it was necessary to remove the water. When the swelling becomes so large as to render it necessary to discharge the water, the operation may be either *palliative* or *radical*. The object of the first is merely to remove the water, after which the disease commonly returns; by the second, an adhesion is intended to be produced between the surfaces of the vaginal coat and albuginea, and consequently the cavity in which the water was collected is entirely obliterated. In making choice of these modes of treatment, it is necessary to attend to the following rules. 1. When the

Of Hydrocele.

the hydrocele is large, it is safer to perform the palliative operation; and afterwards when it has again collected in less bulk, the radical one may be employed. 2. When the state of the testicle is not accurately ascertained, it is better first merely to discharge the water, which allows it to be completely examined. 3. The palliative operation should be employed in all cases where the disease is connected with a morbid state of any contiguous organ. 4. In all other cases, the radical operation is preferable.

Palliative Operation.—The matter may be discharged either by a puncture made with a lancet or by a small trocar.

* See Plate DXIV.

When the trocar * is to be introduced, the posterior part of the tumor should be firmly grasped in the left hand, so that the fluid is pushed to the anterior and inferior part of it. A puncture is to be made, with a lancet, through the integuments at the most prominent part of the swelling, large enough to admit readily the trocar, taking care to avoid any large superficial vein. The trocar is then to be pushed through the coats of the tumor perpendicularly; but when it has entered the cavity, which is known by the feeling of a sudden want of resistance, the point should be directed upward, and carried forward a sufficient way; so that the surgeon is assured of its being within the cavity so far that there is no risk of its falling out.

After all the matter has been allowed to flow out, and the canula withdrawn, the wound should be covered with a piece of sticking plaster, and the scrotum supported by a suspensory bandage. If the operation is to be done with a lancet, an incision should be first made through the skin, rather larger than what is necessary into the cavity. Then a puncture is to be made through the tunica vaginalis, which will allow the water to flow out; and the discharge may be assisted by the introduction of a probe, director, or hollow tube, into the opening. The trocar should always be employed for this operation, except when the hydrocele is so small that the testicle is in danger of being wounded by it, or when there is any enlargement of the testicle accompanying the hydrocele, the nature of which is not well understood, or if the tunica vaginalis is extremely thick and the fluctuation not distinct.

Radical Operation.—An obliteration of the tunica vaginalis may be produced either by an infusion of *lymph* on the surfaces of the tunica vaginalis and albuginea, or by the process of *granulation*. The first is effected by injecting into the cavity a stimulating fluid to produce inflammation and adhesion; the second by laying open the cavity to produce inflammation and suppuration, and cause it to fill by granulation.

By Injection.—Dr Monro *primus* first proposed and adopted this ingenious, yet simple mode of cure; and it is now that which is most generally practised in all cases of hydrocele not attended with any peculiarity or puzzling symptom. The fluid contained in the tunica vaginalis, is to be discharged by a trocar, in the manner recommended in the *palliative* treatment. The trocar for this purpose should be of a rounded form, which is either altogether cylindrical, or only a small slit at its extremity; for that of *Andrè*, which is flat and slit up at both sides, is apt to allow the fluid to be effused into the cellular membrane of the scrotum; an accident which we have seen repeatedly happen, and always frustrates the object of the operation.

The fluid is then to be injected through the canula either by a syringe (Plate DXIV.), which has a moveable *stop-cock*, that it may be filled as frequently as is necessary, or by an elastic bottle, which has a valve in its pipe, so as to allow the fluid to pass forward, but to prevent its exit. It is not necessary to inject as much fluid, as there was water in the hydrocele; it answers well to fill the cavity moderately, and by gentle strokes on the scrotum agitate it over the whole surface. The fluid most commonly employed is *port wine*. Some recommend it to be diluted, but it is better to use it pure, and allow it to remain a longer or shorter time according to the degree of pain it excites, and the general irritability of the patient. In hospitals, other fluids are used, as being less expensive. Mr Cline of St Thomas's hospital employs a solution of the sulphate of zinc ℥i. ad lbi. From five minutes to a quarter of an hour is in most cases a sufficient length of time to allow the wine to remain. If it excite severe pain in the testicle or cord, it may be detained more or less time. A considerable degree of uneasiness is always to be wished for in order to secure success in the operation. After the wine is withdrawn, the wound should be covered with a piece of sticking plaster or caddis; the scrotum well supported with either pillows or a truss, and the patient put to bed. The operation excites more or less swelling in a longer or shorter period. The medium effect on the testicle is to cause it to swell about the bulk of a turkey's egg in four or five days; and the surgeon should, by pursuing the antiphlogistic regimen, moderate as far as in his power the inflammatory symptoms to that pitch, and by an opposite treatment bring them up to that degree should they be too mild. Low diet, local or even general blood-letting, purging, the horizontal posture and fomentations, are the most powerful means to arrest inflammation; but if the patient has little pain, he should live on a nourishing diet, and some local stimulant may be applied over the scrotum until a sufficient degree of inflammation comes on. If the inflammatory symptoms abate, the swelling disappears; and it is adviseable to wear always afterwards a bag truss to support the whole scrotum. In some cases the water again collects, and then the operation should be repeated; but it requires caution, as the relative situation of parts is sometimes altered from some partial adhesions having formed between the tunics.

We have seen frequently cases where it was thought that the water has been regenerated a few days after the operation, which swelling afterwards disappeared. This probably arises from an effusion in the cellular membrane, but it requires no particular treatment.

By Incision.—After grasping the tumor firmly, an incision is to be made through the skin with a scalpel, from its superior to its inferior part. A puncture is to be made towards the upper part, with a lancet, large enough to admit the point of the fore finger; the fluid is allowed gradually to escape through the opening; and the tunica vaginalis is to be laid open its whole extent with a probe-pointed bistoury in the same direction as the incision through the integuments. Pledgets of lint dipped in oil,

Of Hydrocele.

oil, or covered with simple ointment, are to be put between the lips of the wound, down to the bottom of the cavity, one on each side of the testicle; and the edges of the scrotum are to be brought together either by straps or suture. A single ligature put through the integuments opposite the testicle, answers best, and prevents the testicle from being pushed without the edges of the wound in consequence of the degree of swelling the operation occasions. The whole should be covered with a pledget of ointment, and suspended in a tight bandage.

In three or four days after the operation, the external dressings should be removed; and in one or two days more, the pledgets interposed between the tunica vaginalis and testicle may be taken away and renewed. The ligature should be cut out whenever the swelling of the part begins to abate, or at any time when it appears to create irritation. During the cure, great care should be taken, first, by the introduction of slips of plaster, to prevent the union but from the bottom; secondly, to guard against the collection of matter in any cavity; thirdly, to prevent the lips of the wound separating far, thus exposing the testicle and protracting the cure; and fourthly, to lay open freely any sinuses which may form. The cure goes on much more rapidly by persevering in the horizontal posture, and keeping the scrotum well supported. The bowels should be always kept open and regular, and when suppuration has begun, the patient's strength should be supported by a nourishing diet and bark or port wine, if necessary. The cure takes from three to eight weeks in most cases. This mode of operating is the most eligible when there is any ambiguity in the case, as it allows the testicles to be accurately examined, and castration performed if necessary. It ought also to be performed when the tunica vaginalis is much thickened and hardened, and it is sometimes necessary, even to cut away some of the hardest portions. The modes of curing hydrocele by a *seton*, *caustic*, &c. are now generally given up.

When to be adopted.

Sect. III. *Dropsy of the Thorax*, or *Hydrothorax*.

The fluid is sometimes confined to one, and sometimes affects both sides of the chest. It is commonly of a brown or yellow colour; sometimes it is reddish from a mixture of blood. Its chemical qualities are those of serum. When it is accumulated in a large quantity, the lungs are more or less compressed. Dr Baillie has seen a lung not larger than the closed fist. It is also in some instances accompanied with adhesions between the surface of the lungs and pleura.

The existence of water is known by the following symptoms. Respiration is short and difficult; and the patient cannot rest in bed, except the head and trunk be elevated from the horizontal posture. The sleep is often interrupted by alarms and disagreeable dreams, and the patient suddenly starts from it with a sense of suffocation: he is unable to stoop much forward, or raise any thing from the ground. There is sometimes a teasing cough, with little expectoration. During the progress of the disease, the pulse is very variable; but it is generally irregular. The countenance is pale, and the lips and cheeks of a purple hue. The urine is diminished in quantity, and of a high colour. The bowels are generally constipated. The feet and legs are commonly anasarcous. The undulation of a fluid may be heard by the patient himself, and moving the body by sudden jerks will sometimes assist in discovering the disease. The affected side has in some cases been observed to be enlarged.

Of Hæmatocele.

This disease is treated by the exhibition of internal medicines, where the quantity of water is small; but when it collects in such a quantity as to threaten suffocation, it ought to be discharged by an opening made into the cavity of the thorax. The incision ought to be made between the fifth and sixth ribs, half way between the sternum and spine; two inches in length through the skin. The subjacent parts ought to be cautiously divided; and the incision should be directed rather towards the upper part of the sixth rib, to avoid wounding the intercostal artery and nerve, which creep along the inferior edge of the fifth rib. The pleura, which is distinguished by its bluish colour, should be carefully cut with the point of the knife; so that, in case of adhesion, the lung is not wounded: and if the water flows out, a canula should be introduced into the opening. If it does not, in consequence of adhesion, another incision must be made. Great care should be taken to prevent the admission of air, and for that purpose, the opening should be made valvular, by pulling up the skin which is to be cut through. If the quantity is very great, it may be drawn off at two different intervals; or if it is collected in both cavities of the thorax.

Sect. IV. *Dropsy of the Pericardium*.

Water is sometimes found in the *pericardium* when there is none in any other cavity of the thorax, but it is generally accompanied with a collection of water in some of them. The symptoms of this disease are nearly similar to those of hydrothorax; and we find that Dessault and other very eminent surgeons have not been able to distinguish them. Dr Baillie says, "that the feeling of oppression is more accurately confined to the situation of the heart; and the heart is more disturbed in its functions in dropsy of the pericardium than in hydrothorax." It is also said, that a firm undulatory motion can be felt at every stroke of the heart.

If the existence of this complaint is ascertained, and if the quantity of water is suspected to be great, it may be perhaps advisable to discharge it, as practised in one case by Dessault, by making an opening between the sixth and seventh ribs of the left side, opposite to the apex of the heart.

Sect. V. *Blood effused in the Tunica Vaginalis.* (Hæmatocele).

The effusion of blood within the cavity of the vaginal coat is characterised by the sudden appearance of the tumor, by its wanting the transparency of a hydrocele, by its greater weight, and by its being more commonly occasioned by some accident. It is usually produced by the trocar used in performing the *palliative* operation wounding a vessel which pours its blood into the vaginal cavity; it is still more apt to happen when a lancet is used and a varicose vessel punctured. It also takes place from the rupture of a varicose vessel by the sudden depletion of a large hydrocele.

If the swelling is small, it may disappear by the local use

Of the Diseases of the Bones. Carus.

A bone may become carious first in its internal parts; and that from external injury, as well as from a vitiated state of the animal fluids. Authors seem not to agree as to the technical term for this kind of disease of the bones; some calling it *cancer* or *gangræna ossis;* others, *spina ventosa*, from the pointed extuberances usually attendant on this disorder of the bone; and some again, *teredo*, from the appearance of the carious bone, like wood that is worm-eaten.

Abscess.

It is universally allowed, that this disease takes its rise from matter being formed either in the diploe, or in the marrow: whenever obstruction is begun in the vessels expanded on, or terminating in, the medullary cysts, the consequence will be inflammation, and, if not early removed, matter will form; for this reason this case may be called *abscessus in medulla.* Whenever, then, a patient complains of dull heavy pain, deeply situated in the bone, consequent to a violent blow received on the part some time before, though the integuments appear perfectly sound, and the bone itself not in the least injured, we have great reason to suspect an abscess in the medulla. Children of a bad habit of body, though they have not suffered any external injury, will often become lame, and complain of the limb being remarkably heavy; and though not attended with acute pain, yet the dull throbbing uneasiness is constant. If rigors happen during the time the patient labours under this indisposition, it generally implies that matter will be formed within the substance of the bone. If the extremities of the diseased bone swell, or if it becomes enlarged throughout its whole extent, it may be known to be an abscess in the medulla, or the true spina ventosa, as it is called: if neither of these symptoms take place, the great insensibility of the bone in some subjects will prevent that acuteness of pain usual in other parts where matter is formed, though the acrid matter is eroding the bone during the whole time it is contained within it. This matter at length having made its way through, arrives at the periosteum, where it creates most violent pain. The integuments then become swelled and inflamed, and have a sort of emphysematous feel. On being examined by pressure, the tumor will sometimes be lessened, from part of the matter retiring into the bone: from this appearance to the touch, most likely the name of *ventosa* was added to the term *spina*.

When we are assured of matter being under the periosteum, we cannot be too early in letting it out, as it will save a considerable deal of pain to the patient, though probably it may not be of any considerable advantage in respect to the carious bone; for, where the fluids in general are vitiated, no chance of cure can be expected from topical remedies; but where the constitution is mended, nature will sometimes astonish us in her part, as the carious bone will be thrown off from the epiphyses, or the teredines will be filled up by the ossific matter that flows from the parts of the bone where some of the spinæ have come away.

If proper medicines are given, the children well supported, and the parts kept clean and dry, patience and perseverance will frequently give great credit to the surgeon. In case it should have been thought advisable to apply a trephine, to give free discharge to the matter, the washing it away, as well as the small crumblings of the carious bone, by means of detersive and drying injections, has been known to contribute greatly to the curing this kind of caries, after the habit of body in general had been mended.

Besides those above mentioned, the bones are liable to two opposite diseases; the one termed *friabilitas*, the other *mollities;* the former peculiar to adults, the latter more frequent in infants, though sometimes seen in adults, from a vitiated state of their juices.

Rickets.

From repeated salivations, the bones in old people have been rendered extremely brittle; insomuch that in many subjects they have been fractured merely from their weight and the action of the muscles: but in such cases, this is not owing to the friability of the bones, but to the loss of substance, from the erosion of the bone by an acrimonious humour thrown on it: to which cause perhaps may be attributed the disease called *rickets* in children. The effects of scorbutic humour in rendering the bones soft in many instances, have often been remarked.

By proper diet, gentle friction, exercise, and cold bathing, rickety children will frequently get their constitution so much changed, as that, by the time they arrive at the age of 20 years, there shall not remain the least vestige of their former disease. The epiphyses are generally most affected in this species of the disorder. For want of early attention to invalids of this sort, we find that their bones not only become soft, and yield to the powers of the muscles, but remain distorted during the rest of life, though they have acquired a perfect degree of solidity. In such cases, therefore, the assistance of a skilful mechanic is necessary both to support the parts improperly acted on, and to alter the line of direction of the distorted osseous fibres.

Though the curvature of the extremities, or thickness of the ends of the bones near their articulations, may give the first alarm to those who are constantly with children, yet there are other symptoms that give earlier notice; which if they had been timely discovered, it is highly probable that the curvature of the limbs in many children might not have happened. The belly generally becomes larger in this disease, from the increased size of the contained bowels; the head then becomes enlarged; then a difficulty of breathing succeeds, which is generally supposed to be the effects of taking cold. The sternum is elevated and sharp, and the thorax becomes contracted; the spine is protruded in several parts; the pelvis altered, according to the pressure of the parts within, and habitual inclination of the patient to obtain that line of direction in which the perpendicular from the centre of gravity may fall within the common base of the body; the extremities of the cylindrical bones, and the ends of the ribs next the sternum, become enlarged; soon after this the bones in general become soft and flexible, yielding in such directions as the strongest muscles determine.

Where the affection of the mesenteric glands is evident, Mr Bromefield asserts, that after a dose or two of the pulvis basilicus to empty the intestines thoroughly, the purified crude quicksilver is by much the most efficacious medicine to remove obstructions in those glands. When the belly begins to soften and subside, the chyle passes without interruption, and the child begins to get flesh; then the cold bath becomes truly serviceable, and the decoction or cold infusion of the Peruvian bark is a proper

Of the Diseases of the Bones.

proper restorative; but the cold bath used too early, or the bark given before there is a free circulation of chyle through the lacteals, would be very injurious.

Palsy of the lower extremities.

Among the diseases of the bones we may likewise take notice of that *palsy of the lower extremities* which takes place, as is generally supposed, in consequence of a curvature in some parts of the spine. To this distemper both sexes and all ages are liable. When it attacks an infant of only a year or two old or younger, the true cause of it is seldom discovered until some time after the effect has taken place. The child is said to be uncommonly backward in the use of his legs, or it is thought to have received some hurt in the birth. When the child is of an age sufficient to have already walked, and who has been able to walk, the loss of the use of his legs is gradual, though in general not very slow. He at first complains of being very soon tired, is languid, listless, and unwilling to move much or at all briskly. Soon after this he may be observed frequently to trip and stumble, though there be no impediment in his way; and whenever he attempts to move briskly, he finds that his legs involuntarily cross each other, by which he is frequently thrown down without stumbling; and when he endeavours to stand still in an erect posture without support, even for a few minutes, his knees give way and bend forward. As the distemper advances, it will be found that he cannot, without much difficulty and deliberation, direct either of his feet exactly to any one point; and very soon after this, both legs and thighs lose a good deal of their natural sensibility, and become quite useless. In adults, the progress of the disease is much quicker, but the symptoms nearly the same.

Until the curvature of the spine is discovered, the complaint generally passes for a nervous one; but when the state of the back bone is adverted to, recourse is almost always had to some previous violence to account for it. That this might have been the case in some few instances might be admitted; but in by far the greatest number some predisposing cause must be looked for.

Mr Pott, who has written a treatise upon this disease, recommends it to our observation, that though the lower limbs are rendered almost useless, or even entirely so, yet there are some circumstances in which it differs from a common nervous palsy. The legs and thighs, though so much affected, have neither the flabby feel of a truly paralytic limb; nor have they that seeming looseness at the joints, nor the total incapacity of resistance, which allows the latter to be twisted almost in all directions: on the contrary, the joints have frequently a considerable degree of stiffness, particularly the ankles; by which stiffness the feet of children are generally pointed downward, and they are prevented from setting them flat upon the ground.

At first the general health of the patient seems not to be at all, or at least not materially affected; but when the disease has continued for some time, and the curvature is thereby increased, many inconveniences and complaints come on; such as difficulty in respiration, indigestion, pain, and what they call *tightness at the stomach*, obstinate constipations, purgings, involuntary flux of urine and fæces, &c. with the addition of some nervous complaints, which are partly caused by the alterations made in the form of the cavity of the thorax, and partly by impressions made on the abdominal viscera.

Mr Pott was led to a knowledge of the true cause and cure of this distemper, from observing the case of a youth of 14, who was restored to the use of his limbs immediately after a seemingly accidental abscess near the part. From this he was inclined to think, that the curvature of the spine was not the original cause of the disorder, but that the surrounding parts were predisposed towards it by some affection of the solids and fluids there; and he was confirmed in these suspicions by a variety of appearances, which he observed both in the living body and upon dissection of the subject after death; all of which are narrated at full length in his treatise upon this subject.

"The remedy (says he) for this most dreadful disease consists merely in procuring a large discharge of matter, by suppuration, from underneath the membrana adiposa on each side of the curvature, and in maintaining such discharge until the patient shall have perfectly recovered the use of his legs. To accomplish this purpose, I have made use of different means, such as setons, issues made by incision, and issues made by caustic; and although there be no very material difference, I do upon the whole prefer the last. A seton is a painful and nasty thing: besides which it frequently wears through the skin before the end for which it was made can be accomplished. Issues made by incision, if they be large enough for the intended purpose, are apt to become inflamed, and to be very troublesome before they come to suppuration; but openings made by caustic are not in general liable to any of these inconveniences, at least not so frequently nor in the same degree: they are neither so troublesome to make or maintain. I make the eschars of an oval form, about two-thirds of an inch in diameter on each side of the curve, taking care to leave a sufficient portion of skin between them. In a few days, when the eschar begins to loosen and separate, I cut out all the middle, and put into each a large kidney-bean: when the bottoms of the sores are become clean by suppuration, I sprinkle, every third or fourth day, a small quantity of finely powdered cantharides on them, by which the sores are prevented from contracting, the discharge increased, and possibly other benefit obtained. The issues I keep open until the cure is complete; that is, until the patient recovers perfectly the use of his legs, or even for some time longer: and I should think that it would be more prudent to heal only one of them first, keeping the other open for some time; that is, not only until the patient can walk, but until he can walk firmly, briskly, and without the assistance of a stick: until he can stand quite upright, and has recovered all the height which the habit or rather the necessity of stooping, occasioned by the distempers, had made him lose."

Chap. VII.

Of the Diseases of the Arterial System.

Sect. I. *General Remarks on the Diseases of the Arterial System.*

Of the Diseases of the Arterial System.

The diseases of the vascular system form an important class in systems of Nosology. In the diseases of every organ, the action of the arteries and veins is more or less influenced, though the changes of structure to which these vessels are subject are very limited. The only diseases

Of Varicose Veins.

Astley Cooper. There are several instances of this artery having been successfully tied, so that there is sufficient encouragement to adopt the practice in future cases, where there is room to tie the artery above the sternum. The operation is to be done by making an incision on the side of the artery next the trachea, laying bare the vessel, and carefully avoiding the par vagum and the recurrent branch in placing the ligature.

Sect. VI. *Of the Axillary Aneurism.*

Mr Keate of St George's Hospital, tied with success the axillary artery, where it passes over the first rib; and Mr Ramsden has lately tied the subclavian artery for an axillary aneurism. The patient, however, died. A similar operation was attempted by Mr Cooper, but he failed in tying the ligature round the artery, from the bulk of the tumor. Mr Blizzard completely succeeded in performing this operation. The great difficulty felt in these operations was the passing of the ligature below the vessel on account of its depth.

Chap. VIII.

Of the Diseases of the Venous System.

Sect. I. *Of Varicose Veins.*

When the veins of any organ become preternaturally dilated, they are said to be *varicose*. This state of the veins is most usually met with in those which are superficial, and seems to arise either from some mechanical cause preventing the ready flow of blood through them, or from the veins themselves losing the necessary support of the skin and adjacent parts. The gravid uterus, by pressing on the iliac vessels, frequently renders the veins of the lower extremity varicose. Various tumors produce similar effects. We also see the veins of the integuments of old people become tortuous and swelled from no mechanical pressure.

Varicose veins are a frequent attendant on ulcers of the leg, and it has been observed that the ulcer seldom or ever heals until the varix is cured.

Varicose veins of the extremities may generally be much relieved by the application of a proper bandage from the toes upwards; and in cases where this does not give relief, the venous trunk should be tied with a ligature as directed in aneurism.

Sect. II. *Varicose Spermatic Veins* (Varicocele).

The veins of the spermatic cord often remain varicose after inflammation of the testicle, and also in early life without any known cause. The disease is generally easily distinguished by the tortuous irregular swelling. It sometimes, however, acquires a large size; but even then its nature may be readily distinguished by placing the patient in a horizontal position, and applying pressure to the tumor.[a] By this the swelling disappears, and if the upper part be grasped so as to allow nothing to pass out of the abdomen, the swelling will nevertheless be again formed.

The disease occurs most frequently in the left side, and this may arise from the vein in that side not terminating directly in the vena cava, but in the emulgent.

Of the Diseases of the Testicle.

Treatment.—The use of astringents, along with a proper suspensory bandage, will generally afford relief. It has also been proposed to tie a ligature round one or more of the varicose vessels. In one case this was done with complete success.

Sect. III. *Of Hæmorrhoidal Tumors.*

The hæmorrhoidal tumor consists in a dilatation of the veins about the anus and extremity of the rectum. They are round smooth tumors of a purple colour, and more or less painful. They vary in their size and number. Sometimes they are accompanied by a regular periodical discharge of blood (bleeding piles), and in other cases no such discharge takes place (blind piles), and then they are more subject to inflammatory attacks.

Hæmorrhoids occur more frequently in women than in men, and they commonly arise from a long continued pressure on the rectum; as obstinate costiveness, prolapsus, gestation, calculus or tumors about the bladder, uterus, or vagina.

Treatment.—When they are inflamed, local bleeding, fomentations and poultices give much relief, care being taken at the same time to keep the tumors within the anus, and to keep the bowels very open by mild laxatives and clysters.

In some cases the piles acquire a very considerable bulk, and form a number of large and loose tumors round the anus, which prevent the free discharge of fæces. In such cases the tumors ought to be removed, and this may be best done with the knife; or, as sometimes happens, if they be so situated as to render this dangerous, they may be removed by a ligature.

Chap. IX.

Of the Diseases of the Glandular System.

General Remarks on the Pathology of the Glands.

We observe a vast variety of diseases of the glandular system, and the greater number of these arise from a morbid state of their secretions. We see striking examples of an increased secretion in diabetes, in the mercurial salivation, and in many bilious disorders: on the other hand the natural secretion is diminished in suppression of urine, in dryness of the mouth, &c.

An alteration in the secretory function is not, however, the only disease of this system; there are a great number of organic alterations of structure with which they are affected, and a variety of tumors are also found to form in them. As, however, most of the principal glands of the body are situated within the larger cavities, few of their diseases come within the province of the surgeon.

Sect. I. *Of the Diseases of the Testicle.*

1. *Of the Schirrus and Cancer of the Testicle*, (Sarcocele).

This affection is liable to a considerable variety in its appearances; and as in the description of it which has been given by authors, they have included symptoms of diseases

Of the Diseases of the Testicle.

diseases which are very different from the true scirrus.

The most remarkable symptom of scirrhous testicle is a gradual enlargement and induration of the body of the gland or epididimis, advancing from one point, without marks of inflammation or pain. Along with its increase in bulk it acquires additional hardness, and its surface, from being smooth, turns by degrees unequal and knotty. The integuments become of a purplish red, at last ulcerate, discharge a fœtid ichor, and a cancerous fungus grows from the wound. The spermatic chord also becomes enlarged, knotty, and hard, and the glands of the groin swell, the health of the patient becoming entirely destroyed, and at last carrying him off in the greatest misery.

Symptoms.

The progress of this disease is in general slow, and is commonly attended with an aching sensation about the testicle, and severe pain darting from it to the loins, particularly when the testicle is not supported. The disease is most frequent in the advanced stages of life. It commonly arises from an unknown cause. It has at times been known to succeed a venereal affection, but this is by no means common, and it is sometimes preceded by a blow or some accident which excites inflammation.

Appearances on dissection.

When the scirrhous testicle is examined by dissection, Dr Baillie observes that "it is found to be changed into a hard mass of a brownish colour, which is generally more or less intersected by membrane. In this there is no vestige of the natural structure, but cells are frequently observable in it containing a sanious fluid, and sometimes there is a mixture of cartilage." Sometimes water is found collected in the cavity of the tunica vaginalis, but more frequently the tunics adhere to each other. When the spermatic chord is affected, that exhibits the same changes of structure as the testicle itself.

Treatment.—When a testicle is known to be affected with the true scirrhus, all prospect of a cure by the exhibition of internal or external remedies becomes hopeless, as there is no fact better known and more severely felt in the history of scirrhus and cancer in every organ of the body, than its resisting all means of relief, but by the complete removal of the diseased part. In a few rare cases, by a moderate diet, keeping the bowels open, suspending the tumor, avoiding violent exercise, or any thing which may prove a source of irritation, the disorder has been said to be not only prevented from increasing, but has in a gradual manner entirely disappeared; but we much suspect that these cases whose termination was so favourable, have not been of a schirrous nature. This is probable from what is known of the termination of scirrhus in other organs of the body, and also from the difficulty we have in forming an accurate diagnosis in the diseases of the testicle. There are, we hesitate not to say, many testicles extirpated which might have been saved; for our imperfect knowledge of the various morbid changes of this organ, has made it too much an established practice to extirpate all testicles which are enlarged and hard, and which do not yield to mercury.

When, however, by an attentive examination of the history and symptoms of the disease, no doubt is entertained of its scirrhous or cancerous nature, the more speedily the tumor is removed, the better chance there is of a permanent cure. In performing the operation, care should be taken to remove completely every part suspected to be diseased, and no part of the skin should be left with a view of covering the wound more completely which has the least discolouration or mark of disease.

Mode of extirpating the Testicle.

The parts being previously shaved, the patient is to be laid upon a firm table covered with a blanket or mattress. His legs should hang over the table, and be supported by assistants. An incision is to be made through the integuments with a common scalpel, extending from a little above the external abdominal ring to the bottom of the scrotum. The cellular membrane around the spermatic chord is to be dissected back, and the chord laid fairly bare; and this part of the operation is much more easily accomplished when the incision through the skin is very free. A ligature of considerable thickness is to be put underneath the chord, and it may be introduced with a blunt-pointed needle or instrument (fig. 17. Plate DXIII.). The extent of the disease in the chord should now be examined as accurately as possible, and the ligature should be tied firm with a running knot, as far above the diseased part as possible. If any hardness extends to the external abdominal ring, the chord may be even dissected up along the inguinal canal, and the ligature put on at that place. The chord may be divided one-fourth of an inch below where the ligature has been applied, and then the whole of the testicle and its vaginal coat may be readily dissected away, taking care not to cut into the vaginal cavity of the opposite side of the scrotum. After the testicle is removed, the ligature should be loosened, and the spermatic artery and veins included in separate ligatures. The ligature upon the spermatic chord is to be left loose, so as to act as a tourniquet if a hæmorrhagy should ensue. Much care should also be taken to secure any arteries of the integuments of the scrotum which are seen bleeding; as we once met with a very troublesome hæmorrhagy from one of these retracting among the loose cellular texture, and not being seen after the operation. It therefore will be a good general rule to tie those with ligatures immediately after they are divided.

The wound is to be dressed, so as to be healed if possible by adhesion; and this may generally be accomplished, except at the upper part where the ligatures come through. With this view the wound and scrotum are to be carefully washed, and two or three stitches, as may be thought most expedient, are to be put through the edges of the wound; for in a part like the scrotum, where the skin is loose and puckered, it is hardly possible to apply adhesive straps with sufficient accuracy, so as to serve the purpose. Small pieces of adhesive plaster, however, should be neatly placed between each of the stitches, along the whole extent of the wound, and a pledget of simple ointment and compress afterwards to be laid over it, the whole being secured with a T bandage.

After the operation, the patient is to be put to bed, being directed to lie on his back with a pillow between the thighs, so as to support the scrotum.

Opiates should be given to allay pain, and if any inflammatory symptoms supervene, bleeding at the arm should be had recourse to without the least hesitation; for

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for we have made a general remark, that after almost all surgical operations, there has scarcely ever an instance occurred where the patient died from loss of blood, and on the contrary, that almost all patients who have lost much blood, or who have been previously much emaciated, have recovered more quickly than these in full health. The antiphlogistic regimen in almost every case should be rigidly pursued, until at least all inflammatory appearances of the wound are gone, and a healthy suppuration commenced.

Mode of dressing the wound.

About four, five, or six days, according to circumstances, the dressings should be removed, and if the wound is healed by adhesion, the stitches may be withdrawn, and the edges of the wound kept together by adhesive plasters. The ligature on the spermatic chord may now be safely taken away, and that round the spermatic artery and veins generally comes readily away before the tenth dressing. In this manner the wound should be dressed daily until it is cicatrised. When the wound, instead of healing by adhesion, suppurates, the stitches may be taken away as soon as it appears that the edges of the wound can be accurately kept together with the adhesive plasters; for if the stitches are allowed to remain long, they generally ulcerate the contiguous skin, and form sinuses, which continue to discharge matter after the rest of the wound has healed. The wound should be dressed once or even twice in twenty-four hours if the discharge be profuse, and care should be taken to wash away with a sponge any matter which may be deposited on the sound skin of the scrotum or groin. The edges of the wound should be brought accurately together at each dressing, any matter collected in different parts of it should be gently squeezed out, so as to prevent any lodgement from taking place. Should the patient become weak from the continuance of the discharge, he should be ordered a nourishing diet, with a proper proportion of wine; and if the discharge be at any time thin and very profuse, we have found much benefit in such a case from the internal use of bark (cinchona).

2. *Inflammation of the Testicle* (Hernia humoralis).

Symptoms.

Inflammation is one of the most frequent diseases of the testicle. Sometimes the inflammation is confined to the substance of the testicle, at other times it affects the epididimis, and in some cases it spreads to the albuginea and vaginalis. The surface of the inflamed testicle is uniform and smooth, more or less sensible to the touch, equally firm and tense throughout when pressed upon, and the integuments are generally discoloured, having a blush of redness, and interspersed with varicose veins. When examined by dissection, the testicle exhibits, according to Dr Baillie, precisely the same appearances as the inflammation of the substance of other parts. The vas deferens sometimes partakes of the inflammation, its coats becoming considerably thickened, and in other instances the veins of the spermatic chord become varicose. Inflammation of the testicle most frequently is preceded by gonorrhœa, but it also occurs from a variety of causes. It occurs sometimes from exposure to cold, from violent exercise, and is often excited from blows, riding on horseback, &c.

The inflammation of the testicle concomitant of gonorrhœa generally begins by spreading along the vas deferens from the prostate gland through the inguinal canal till it comes to the testicle; it is in most cases attended with excruciating pain from the rapidity of its progress; and as it commonly comes on when the gonorrhœal discharge diminishes or disappears, and subsides when the discharge returns, many authors have supposed that it was a true metastasis of the venereal matter.

If the disease be left to itself, the body of the testicle becomes more hard and painful, with all the symptoms of local inflammation, and the tumor sometimes acquires an enormous bulk. Sometimes the inflammation is accompanied with violent fever, with a pulse hard and strong in the plethoric, and feeble and rapid in constitutions which are delicate and irritable. The patient also often complains of pains in the loins, and has nausea and vomiting. In general the discharge from the urethra diminishes considerably, and often it ceases altogether before the testicle becomes affected; but sometimes that does not happen in any remarkable degree till one or two days after the swelling has begun to appear. It never happens that both testicles are affected at the same time, but when the swelling of one disappears, often the other begins to be attacked.

The testicles sometimes swell and inflame from the absorption of the matter of a chancre, and as the progress of the swelling is in such cases slow, and generally more irregular, it has sometimes been mistaken for a schirrous testicle; but an investigation into the history of the case, and particular attention to the appearance of the skin of the scrotum, and any symptoms of the venereal disease in other parts of the body, will generally lead to a knowledge of the true nature of the case. It sometimes happens that inflammation is chiefly confined to the spermatic chord, and in many cases it affects the epididimis alone. The extent of the disease is always easily ascertained by a careful examination of the parts. It seldom happens that both testicles are inflamed at once; we have, however, remarked this to take place. Inflammation, such as has now been described, generally abates by the application of proper remedies: in some cases, however, an induration of the testicle remains. It terminates, though rarely, in suppuration.

Treatment.—When an inflammation has arisen from a blow, from exposure to cold, or from any injury done to the testicle, it ought to be treated according to the general plan laid down of treating inflammation of other organs. Local bleeding by leeches is a most useful remedy, and ought to be the first thing employed if there is the slightest pain, tenderness, or redness of the scrotum. Fomenting the scrotum with warm water, or a decoction of poppy heads, chamomile flowers, or tobacco leaves, often gives much relief, and great attention should be paid in supporting the testicle with a silk net truss (Plate DXIV.). Some have also used with success the application of ice or snow to the part. If the symptoms and pain are very violent, bleeding at the arm may be necessary. The bowels should be kept open, and even purged; the patient should be confined to a low diet, and he should keep as much as possible to the horizontal posture, as this is found to be of the greatest importance in promoting the cure.

When the inflammation arises from gonorrhœa, particular attention must be paid not only to the disease in the testicle, but to that of the urethra. Indeed it is of much importance in the treatment of gonorrhœa to use means

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means to prevent the testicles from becoming inflamed; and as every thing which causes a suppression of the discharge tends to produce a swelling of the testicle, it is natural to suppose, that in order to prevent this troublesome disorder, every thing should be avoided capable of increasing the irritation and inflammation of the urethra, as exposure to cold, violent exercise, ill chosen injections, and balsamic medicines; but, above all, the use of a suspensory is most efficacious, and Swediaur * recommends one to be worn in every case of gonorrhœa from the commencement of the disease, to prevent all risk of the testicles becoming inflamed. When the inflammatory symptoms are severe, the treatment should be adopted as we have recommended in common inflammation of the testicle. If the discharge from the urethra is stopt, means should be used to restore it. Whenever the inflammatory fever is rendered more mild, Swediaur recommends, with this view, a dose of opium to be given, and according to circumstances, an injection composed of two or three ounces of oil of linseed and decoction of barley, along with fifty or sixty drops of the vinous tincture of opium. This may be repeated every ten or twelve hours, taking care always to have the bowels well opened before using it. Swediaur has found the extract of hyoscyamus in many cases answer better than opium. Fomentating the penis and adjacent parts with warm vinegar and water, injecting warm oil, and the use of bougies, may also be advantageous in promoting the discharge from the urethra.

* *Traité sur les Maladies Vénériennes.*

3. *Induration of the Testicle.*

After the inflammatory symptoms have abated, it generally happens that a degree of swelling and hardness of the body of the testicle, but still more frequently of the spermatic cord or epididimis, remains, and in many cases continues for months, or even during life. This effect takes place from whatever cause the inflammation may have arisen. In many cases the testicle itself remains quite sound, and the epididimis is converted into a very hard unyielding mass, which feels as if it were injected with quicksilver. Sometimes the testicle, whilst it remains hard, diminishes in size, and becomes much smaller than natural. When the testicle is examined by dissection, it is found to have lost its natural structure, and is sometimes changed into a hard brown-coloured mass (Voigtel), intersected more or less by membranous bands; sometimes parts having a cartilaginous quality appear in it, and sometimes cells are formed which contain matter. The seminal vessels are so changed and hardened, that they cannot be distinguished from each other. In some cases the whole testicle has been found converted into a cartilaginous mass, and in a few instances some parts of it have been converted into bone.

Treatment.

The treatment usually recommended in cases of induration of the testicle preceded by inflammation, are strong stimulating and astringent applications; such as solutions of the muriate of ammonia, acetate of lead, sulphate of zinc, &c. either applied by moistening with them a piece of linen, which is to be kept constantly wet, or by using them in the form of a poultice. Frictions with mercurial ointment, either singly or combined with camphor, over the scrotum and perinæum, sometimes produce a good effect; mercurial fumigations to the genital organs have also been recommended. In some cases the internal use of mercury has been found necessary. A mercurial plaster with camphor, or the common soap plaster, is also a good application, and is very useful in defending the testicle.

The internal and external use of the hemlock (*conium maculatum*) has been much recommended by Plenk. Electricity has also been successfully employed. The muriate of lime, and the muriate of barytes, have been used by some authors. Swediaur says that he has known some affections of the testicle produced by gonorrhœa, and also some diseases of the eye from the same cause, cured by the patient getting a fresh infection. In a few cases of induration, and swelling of the testicles, we have employed blistering with good effects. The scrotum should be shaved before this is done; and it is often necessary to repeat the blister several times before the hardness or swelling begin to abate.

4. *Abscess of the Testicle.*

Symptoms.

It sometimes, though rarely happens, that the testicle suppurates. The matter which is formed, is commonly a tough, thready, yellow-coloured substance, which adheres to the surface of the cavity in which it is contained. Sometimes there is only one abscess; in other cases the matter is contained in several small irregular shaped cavities. Sometimes the matter is formed in the very middle of the body of the testicle; in other cases we have observed small abscesses in different parts of the epididimis, the body of the testicle remaining quite sound. When an abscess is formed in the testicle, the structure of the gland becomes more or less changed; generally instead of being soft, and the tubes of which it is composed being easily separated, it degenerates into a hard firm mass.

Treatment.

Abscesses of the testicle should be opened as soon as possible, in order to prevent the substance of the testicle from being destroyed. The presence of matter is learnt by a fluctuation which can be felt externally: but it is often extremely difficult to determine the true situation of the abscess, whether it is formed in the body of the testicle, in the epididimis, or between the albuginea and tunica vaginalis, or in the cellular membrane external to the tunica vaginalis; for when such a degree of inflammation has taken place as to terminate in the formation of an abscess, the accompanying swelling destroys the natural form of the parts, and converts the whole into a shapeless mass. Richter remarks, that there are sometimes soft spots in the testicle, in which it is believed there is a fluctuation. When such swellings are opened no matter is discharged, nothing but blood appears, and the inflammatory symptoms are afterwards increased. The more matter discharged from an abscess of the testicle, the smaller the testicle grows, as the matter is sometimes formed partly of the thready substance of the testicle. Cases have occurred where the whole testicle has been pulled away, the surgeon having mistaken the seminiferous tubes for sloughs. Abscesses of the substance of the testicle seldom heal, and generally a fistulous opening remains, through which there is a permanent oozing of the seminal fluid.

5. *Fistulous Sinus of the Testicle.*

As far as we know, no author has taken notice of this appearance. In one case we observed it very remarkable. The epididimis alone was swelled, and there was

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a thickened portion of scrotum adhering to one part of it, in which there was a small *sinus*, and through which the seminal fluid constantly oozed. In a similar case the sinus was laid open, but with no good effect; for a small opening remained unhealed, through which the semen continued to be discharged.

6. *Scrofulous Testicle.*

Symptoms.

When the testicle is affected with scrofula, it presents some of those general characters of scrofula in other glandular parts. Its tubular appearance is destroyed; it becomes enlarged; and when cut, it is found to be composed of a dull white substance, of the consistence of curd, which in some parts is mixed with a thin puriform fluid. The scrotum is in almost all cases involved in the disease; it becomes red and inflamed, and the vaginal coat adheres to the albuginea. Abscesses also form in various parts of the cellular membrane of the scrotum, which sometimes communicate with the body of the testicle. This disease generally occurs during the early periods of life, and most commonly only one testicle is affected with it. Sometimes, however, when one recovers, the same disease attacks the other.

Treatment.

In most cases of this kind surgical aid does not avail much, for the progress of the disease cannot be checked by any internal and external remedies. All that can be done is to relieve the inflammatory symptoms, to allay pain, and to prevent the formation of sinuses. With a view to alleviate the symptoms of inflammation, nothing is so beneficial as the application of leeches to the scrotum, and the use of fomentations and poulticing, or solutions of the acetate of lead. Opiates and laxatives may be also freely given, unless in cases where from experience these are known to disagree. When matter has once formed, the sooner it is discharged the better, and this should be done by a small incision. After one abscess has healed, others are very apt to form in succession; these should be treated in the same manner, and if at any period of the disease sinuses form, they should be at once laid completely open to the bottom; or if they are very deep and extensive, a seton may be introduced; if this, however, does not produce an adhesion of the cavity, they should be laid open with a bistoury in the manner directed when treating of *sinuses*.

7. *Testicle preternaturally small, or wanting.*

After violent attacks of inflammation, or in cases of abscess, the testicle sometimes diminishes greatly in size, is almost entirely absorbed; and in a few instances people have been born with them much smaller than natural (Baillie). Sometimes a testicle has been known to waste away without any known cause, so as to disappear altogether. Sometimes one testicle, and sometimes both remain in the cavity of the abdomen through life; so that a person appears to have only one testicle or to be without them altogether. Mr Hunter suspects that in these cases they are not so perfect as when they descend into the scrotum; and if we were to reason from what is observed in other animals, in the horse particularly, where this by no means unfrequently takes place, it is highly probable that when the testicles do not descend into the scrotum, they are not capable of performing their functions.

These cases, though they cannot be relieved by medical aid, yet they are worthy of the notice of medical men.

8. *Fungus of the Testicle.*

There sometimes arises from the testicle a species of fungous tumor, which was first accurately described by Mr Lawrence, demonstrator of anatomy at Bartholomew's hospital, in London.

Symptoms.

The patient generally assigns the origin of the complaint to some injury. In some cases, it is the consequence of *hernia humoralis*, and in others it appears spontaneously. The scrotum, after a certain length of time inflames, and adheres to the testicle already swelled; at last the skin ulcerates, and the opening thus formed, instead of discharging matter, is filled up with a fungous tumor, which is of a firm texture, and generally insensible. Whilst the fungus is increasing, the inflammation of the scrotum diminishes; and if the fungus is at this time removed, a cicatrix is formed in the skin, which adheres to the testicle. There is sometimes a copious and very fœtid discharge from the whole surface of the fungus. On dissection, the fungus is found to arise from the pulpy substance of the testicle, more or less of which remains according to the duration and extent of the disease.

It may be worth while to remark here, that we have met with one case, where, from an abscess and ulceration of the scrotum, the testicle itself slipt out at the ulcerated orifice, and exhibited very much the appearance of the fungus above described.

Treatment.

This species of tumor may be safely removed by the knife, by ligature, or by escharotics; the removal by the knife is perhaps the safest, and certainly the most expeditious method.

For an account of *Fungus Hæmatodes* in the testicle, we refer to *Wardrop's Observations on Fungus Hæmatodes.*

SECT. II. *Of the Diseases of the Mamma.*

Of the Diseases of the Mamma.

General observations.

From the changes which take place in the female breast at the age of puberty, during the menstrual discharge, and before and after the birth of the child, we ought to expect a considerable variety in the diseases of this organ; and, in considering these, we should always keep in view the powerful sympathy between that gland and the uterine system.

The gland of the mamma is subject to inflammation and abscess. Scrofulous tumors also form in it; it is subject to a particular disease, called milk abscess, to scirrhus, and to other indurations, the nature of which is not well ascertained.

The nipple and integuments around it are subject to particular kinds of excoriations and ulcerations; the lymphatic glands which lie close to the mamma, are also frequently diseased, and the contiguous cellular membrane is subject to those diseases which are met with in the cellular membrane of other parts.

At the age of puberty, when the uterine system becomes fully developed, the female breast swells, turns hard, and becomes tender, or even painful. A change also takes place during pregnancy; the breast enlarges, becomes very tender and painful, and a dark-coloured zone is observed round the nipple. In women who are suckling about the ninth or tenth month after parturition, and sometimes sooner, the menses reappear; and if

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if the woman afterwards continues to suckle, at each monthly return a remarkable change takes place in the milk; it loses its sweetness, acquires a bitterish taste, becomes of a reddish colour, and excites a temporary derangement in the system of the child. Obstructions of the menses, their final cessation, and all the diseases of the womb, affect more or less the mamma; and at the age of puberty, the time of menstruation, during pregnancy, in the early months of suckling, and at the time of the cessation of the menses, blows and other injuries are most apt to produce disease in the mamma.

This consent between the mamma and uterine system ought to be always kept in view when forming our opinion of any disease in these organs; and it is particularly worthy of the notice of surgeons when operations on that organ become necessary.

1. *Of Inflammation and Abscess of the Mamma.*

This disorder occurs most frequently in nurses by the stoppage of the milk, which is always occasioned by sudden or imprudent exposure to cold.

Treatment. In the early stages of the affection, resolution is to be attempted, unless the swelling appears to have an evident tendency towards suppuration. The remedies used in inflammation, in general, seem useful in every case of inflammation of the breasts. When the patient happens to be nursing, a sudden evacuation of blood is apt to diminish the quantity of milk: In such cases, therefore, blood is to be extracted in small quantities at a time. The application of cooling saturnine poultices is adviseable. When suppuration is taking place, fomentations and poultices are to be used, and the matter is to be discharged by making an incision in the most depending part of the tumor.

2. *Of Scirrhus and Cancer of the Mamma.*

Cancer has been met with in the female breast more frequently than in any other part of the body. We have also seen an example of it in that gland of the male; but such instances are extremely rare.

The commencement and progress of a scirrhous tumor in the female breast, is extremely various in different people; and has been often the cause of scirrhous tumors, and tumors of a more benign nature, being mistaken for one another.

Symptoms. Scirrhous tumors have generally made some progress before they are taken notice of. Sometimes they are first felt like a pea underneath the skin, and lying loose over the gland of the mamma; in other instances, a portion of the central part of the gland is found indurated. Of whatever bulk, and in whatever situation the swelling be discovered, it is remarkable for its unyielding and incompressible hardness, and its rugged unequal feel.

When the tumor is small it seldom gives any pain, and the patient generally discovers its presence by accident. In some cases its existence is discovered by an acute pang darting through the breast leading to its examination; but in many cases it acquires the bulk of a large hazel nut or walnut, particularly when the patient is fat, before any circumstance leads to its discovery.

As the tumor increases in bulk, it advances towards the surface of the body and adheres to the skin. The skin then becomes thickened, inflamed, and ulcerated. If the tumor be situated near the nipple, the disease speedily affects that part, sometimes enlarging and hardening it; and in other cases puckering it and drawing it inwards. When the nipple becomes involved in the disease, the sanious fluid formed in the tumor often escapes before the skin ulcerates, by the lactiferous tubes.

The pain which accompanies the tumor in its more advanced form, is generally of a lancinating kind; but its frequency and degree is susceptible of great variety. Sometimes sharp stinging pains pass frequently from the tumor as a centre, and extend through the whole breast; in other cases there is more of a burning heat in the part.

The progress of the disease is generally very slow, and in many cases three, four, or more years elapse before it ulcerates. When ulceration has taken place, the appearance of the ulcer is similar to that we have described when treating of cancer of the skin *; and the progress of the ulceration is often so slow, that many years elapse before the disease proves fatal.

* See Chap. II. sect. IV.

Scirrhous tumors have been met with in the mamma, from the age of twenty or twenty-five, to a very advanced period of life; but they occur about that period, when the catamenia disappear, much more frequently than at any other.

Treatment.—There is no part of practice about which less has been satisfactorily established, than the treatment of scirrhus in the mamma. The good effects of an early extirpation of cancer in the skin is very generally admitted; but the want of success in removing scirrhous mammæ in the hands of many, has not only led some surgeons to desist from performing an operation, except in very recent cases, but has even deterred others from attempting their removal in the first stages. There are no doubt many patients who submit to a painful operation from which no relief can be reasonably expected; on the contrary, the irritation and fever occasioned by it seem to hasten the progress of the disease. But there are others where this practice has had a happier effect, and where the patients have lived for many years without a return of the disease. Whenever, therefore, a scirrhous tumor appears in the mamma, which is moveable and distinctly circumscribed, past experience warrants us in removing it. On the other hand, when any of the absorbent glands have become enlarged and hardened, or when the skin has ulcerated, we believe that the operation should not be resorted to. Some solitary examples of the disease, assuming this form, may have occurred to individuals, where an operation has arrested the progress of the disease; but these, opposed to the vast number of unsuccessful cases, are by no means sufficient to warrant the operation.

Method of Extirpating the Mamma.—In extirpating the mamma, which we shall first suppose is to be done where the skin is sound, and where the tumor has no uncommon adhesion to the pectoral muscle, the patient ought to be placed horizontally in a bed, or upon a table covered with a mattress. Two incisions are to be made with a common scalpel through the skin and cellular substance along the whole extent of the tumor, including a small portion of skin. When the longest diameter of the tumor is across the body, instead of a longitudinal incision, a transverse one is to be made. The integuments being dissected from the mamma on both sides of the incisions, the patient's arm is to be extend-

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ed to save the pectoral muscle; and the whole glandular part is to be detached from the muscle, though a small portion only should be diseased, beginning at the upper side, and separating downwards. After the diseased parts are removed, the wound is to be cleaned with a sponge wrung out of warm water, which will generally render the small bleeding vessels more conspicuous. These are to be tied, and the integuments are to be closely applied to the parts underneath, and retained there by adhesive straps. A large pledgit of simple ointment is now to be laid over the whole; and this is to be covered with a compress of lint, tow, or soft linen; and the dressings to be kept in their place, and moderate pressure made by a circular roller and scapulary bandage.

3. *Of Sore Nipples.*

Women are more generally affected with sore nipples in suckling their first child than at any future period. This may, in some measure, be owing to the smallness of the nipple; but very often it arises from their being unaccustomed to the irritation of sucking. In some cases, the nipples are so flat, and so much sunk in the breast, as to render it difficult for the child to lay hold of them. Here assistance can sometimes be given, by the mother pressing back the prominent part of the breast, so as to make the nipple project between two of her fingers. Should this be insufficient, the nipple may be made to project by applying to it a stout child several months old: but when this cannot be done, breast-glasses * may answer the same purpose. By applying these to the nipple, and sucking out the air, the child will commonly be enabled to lay hold of it.

* See Plate DXV.

The nipples at this time are liable to excoriations, cracks, or chops; which, though not attended with a formidable appearance, are frequently more distressing than large ulcers. Mild, astringent, and drying applications are most to be depended upon in such complaints; saturnine water, or lime-water, will answer; and either ought to be applied warm. After bathing the parts with any of these, the nipple should be covered with Goulard's cerate. Even a little soft pomatum frequently rubbed upon the part, and covered with a soft linen rag, is sometimes found to give considerable relief. But the nipple should be perfectly cleared of these applications before the child is laid to the breast; and this may be done with a little port wine, or equal parts of brandy and vinegar. If proper attention be paid to these remedies, they will commonly be found to have the desired effect; but if the contrary should happen, another remains to be mentioned, which, in different instances, has given great relief: it consists in the application of a thin skin to the nipple, as the neck and part of the body of a swine's bladder with an aperture in it; which, being properly moistened and fixed to the breast, will completely protect it in the time of sucking. As long as the nipples remain any way affected, small cups of glass or tin are useful for retaining the dressings, defending the nipples from the friction of the clothes, and receiving any milk which may fall from the breast.

Anomalous swellings of the mamma.

Swellings and hardnesses are found in the breast which are not of a scirrhous nature. Scrofulous indurations are particularly frequent. They often become old and hard, and are then commonly considered as cases of the *scirrhus*. If the surgeon succeeds in discussing them by means of any kind of remedy, he is apt to think that he has discussed a scirrhus. These scrofulous swellings sometimes inflame, and the progress of the inflammation is very tedious. The breast is long painful before any softening or fluctuation can be perceived. The surgeon then perhaps considers it as an occult cancer, extirpates it, and thinks that he has successfully cured a *cancerous* affection. If the surgeon opens such a suppurating knot before all the hardness is dissolved by the suppuration, and if he makes a large opening, there commonly follows a very malignant ulcer, which may be mistaken for a cancerous sore. Many cases, where ulcerated cancers have been supposed to have been extirpated with success, may have been of this kind.

Venereal indurations are not unfrequent in the breast, and also cause similar mistakes in practice. Encysted tumors are also met with in the breast, and are most commonly of that kind called *meliceris*.

In the breast of young girls, ten or twelve years of age, hardnesses sometimes appear, which disappear as soon as menstruation takes place. Sometimes they do not go away until the first delivery. Sometimes the breast swells to an enormous size, and becomes indeed not hard, but throughout firm, like muscular flesh. In such a case the extirpation has been successfully performed.

Sometimes considerable and often quite hard swellings appear in the breasts, which proceed merely from blood. In such cases blood flows from the nipple at each menstrual period. When the menses disappear with years, the discharge of blood no longer appears from the breast; but then there is a hard not painful swelling arises, which often acquires a considerable size. If it is opened, coagulated and fluid blood is discharged, and a fistula follows, which discharges a purulent fluid, and sometimes pure blood, and often continues several years, without giving great uneasiness. The swelling, which was at first quite hard, sometimes becomes soft, and then the surgeon is commonly induced to open it. Sometimes such swellings are observed in women who have the menstrual discharge; and in such cases the swelling always becomes greater at each period. Sometimes hectic fever and death follow the opening of these tumors. (Monro). The mamma is also subject to *fungus hæmatodes;* for an account of which, we refer our readers to Wardrop's *Observations on Fungus Hæmatodes.*

Sect. III. *Of the Diseases of the Tonsils and Uvula.*

Of the Diseases of the Tonsils and Uvula.

1. *Of the Enlargement of the Tonsils and Uvula.*

The tonsils sometimes grow so large and hard as to become incurable, and even to threaten suffocation. The tumors have been commonly considered to be of a scirrhous nature; but they are neither attended with shooting pain, nor are they apt to degenerate into cancer; neither do swellings return after the tonsils have been extirpated: hence they ought not to be removed till by their size they essentially impede deglutition or respiration; but whenever they do this, they may be removed with safety. The only proper method of removing them is by ligature, which is not only void of danger,

Treatment.

danger, but seldom fails to perform a cure. If the base of the tonsil be smaller than the top, the ligature is to be used as for polypi in the throat; but however broad the base of it may be, much difficulty will seldom occur in fixing it, for the swelling is always very prominent. In diseases of this kind both tonsils are generally affected; but if the removal of one of them forms a sufficient passage for the food, the other may be allowed to remain. When, however, it is necessary to extirpate them both, the inflammatory symptoms produced by the extirpation of the first should be allowed to subside before any attempt be made to remove the other.

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When the form of the tonsils happens to be conical, so that the ligature would be apt to slip over their extremities, Mr Cheselden has recommended a needle (Plate DXV.) with an eye near the point: a double ligature being put into the eye, the instrument is to be pushed through the centre of the base of the tumor, and the ligature being laid hold of by a hook and pulled forwards, the instrument is to be withdrawn; then the ligature is to be divided, and so tied that each part may surround one half of the tumor. This method, however, is scarcely ever found to be necessary.

Enlargements of the uvula.

Enlargements of the uvula, from inflammation or from other causes, may generally be removed by the frequent use of astringent gargles, as of strong infusions of red rose-leaves or of Peruvian bark. But when these fail, and the enlargement is so considerable as to give great uneasiness by impeding deglutition, irritating the throat, and so causing cough, retching, and vomiting, extirpation is the only treatment upon which any dependence can be placed. Excision is the readiest method when the uvula is only elongated; but when the size is considerable, dangerous hæmorrhagies sometimes attend this method; on which account a ligature is preferable.

Treatment.

In performing the operation, the speculum oris (Plate DXV.) is necessary to keep the mouth sufficiently open, and the uvula should be laid hold of by a pair of forceps or a small hook, so as to keep it firm, and prevent it from falling into the throat. After the operation, if the bleeding be considerable, it may be checked by astringent gargles, or by touching the part with lunar caustic; but this will seldom be necessary.

When a ligature is to be employed, it may be readily done according to the method recommended in the extirpation of polypi. A double canula with a ligature may be passed through the nose, or the ligature may be applied according to Cheselden's method in extirpation of the tonsils.

2. *Of Scarifying and Fomenting the Throat.*

In inflammatory affections of the throat, the means commonly employed are gargles, fomentations, emetics, scarification, or topical bleeding. Gargles are useful for cleaning the fauces from mucus, or in cases of ulceration. In relaxation of the parts, they are employed with advantage when made of astringent materials. Fomentations may be of some use when externally applied; but the steam of water, &c. drawn into the throat, by means of Mudge's inhaler (fig. 1.) is preferable. Sometimes it is necessary to draw blood from the part affected. Here recourse may be had to scarifying, which may be readily done by the scarificator (Plate DXIV.

Plate DXV. fig. 11.

fig. 14.). After a sufficient number of punctures have been made, the flow of blood may be promoted by the patient's frequently applying warm water to the punctures. When an abscess forms, notwithstanding the use of these remedies, the matter may be discharged with the scarificator already mentioned.

Chap. X.

Of the Diseases of the Eye and its Appendages.

Of the Diseases of the Eye.

In the account of the diseases of the eye, we shall follow the same principles of arrangement as we have already adopted, and treat of the diseases of each particular texture of which the eye is composed, in the order in which they appear most natural; as the diseases of the *conjunctiva, cornea, iris, crystalline lens*, &c.

Sect. I. *Of Inflammation of the Conjunctiva.*

General remarks.

The general phenomena of inflammation of the conjunctiva, are analogous to those which have been already enumerated, when treating of the inflammation of *mucous* membranes *. Along with the symptoms there enumerated, there are others which arise from the peculiar functions of the organ. The eye cannot endure the usual quantity of light, vision becomes obscured, and there is an increased secretion of tears. The inflammation is sometimes confined to the palpebræ, sometimes to the conjunctiva covering the white of the eye, in some cases to that portion of it which forms the external layer of the cornea, and in others it spreads over the whole of these surfaces. These differences merely regard the extent of the inflammation: but there are others which arise from a difference in the specific nature of the disease, forming three distinct species; 1. The purulent ophthalmia; 2. The purulent eyes of new-born children; and, 3. The gonorrhœal ophthalmia.

* See Chap. III.

1. *Of the Purulent Ophthalmia.*

Symptoms.

The purulent ophthalmia appeared in this country as an epidemic after the return of our troops from Egypt in the year 1801. Since that period, it has spread with the greatest violence over most part of Britain. This disease generally begins with a peculiar purple-coloured redness over the whole eyeball and inner membrane of the eyelids. There is a sudden pain produced in the eye, as if sand or some foreign substance was lodged between it and the eyelid. As the redness increases, the conjunctiva becomes swelled, from the effusion of a transparent fluid in the loose cellular membranes, between it and the sclerotic coat. There is at first a profuse discharge of tears from the eye, and the eyelashes are glued together when the patient awakes. There is soon created intense pain in the ball of the eye, and a dull aching pain in the forehead. The cornea sometimes becomes opaque; and if the violence of the inflammation continues, it ulcerates and ruptures, allowing the aqueous humour to be discharged; after which, an abatement of the inflammatory symptoms generally takes place.

Before the disease advances thus far, the eyelids are generally considerably swelled; and, besides the flow of tears,

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tears, there is a profuse discharge of a puriform fluid. The inflammation usually attacks both eyes, and it begins in one several days before the other.

Treatment.—In slighter cases of the disease, fomenting the eye with a decoction of poppy heads, and a brisk purge, have been found sufficient to abate the inflammatory symptoms. In other cases, however, it has been necessary to draw blood to a very great extent. When the disease occurs in a strong plethoric person, recourse should be immediately had to the lancet, and the operation repeated on any recurrence of the symptoms. It has been the usual practice of Dr Veitch, and of those who have had extensive opportunities of treating this disease, to draw the blood from the arm. A smaller quantity, however, taken from the temporal artery or external jugular vein, would be found to have an equally good effect.

When the purulent discharge becomes profuse, some have recommended the use of collyria, in the form of injections. The aqua camphorata is recommended by Mr Ware; and a weak solution of corrosive sublimate, with opium, has been found to have equally good effects. In those cases where there are much pain and tension in the eyeball and brow, along with a turbid state of the anterior chamber, and ulceration beginning in the cornea, the discharge of the aqueous humour has been attended with much success *. This operation may be easily, and at all times safely performed, by making a puncture with a common extracting knife, through the sound part of the cornea, near its junction with the sclerotic coat.

* See Mr *Ware's Treatise on the Purulent Ophthalmia.*

2. *Of the Purulent Ophthalmia in Children.*

The symptoms of the purulent eyes of children are very similar to those which have been mentioned. The disease generally appears a few days after birth by an increased redness of the palpebral membrane, more or less swelling, and a puriform discharge. Sometimes the membrane swells so much as to evert the eyelids, and render it impossible to examine the eyeball. The cornea becomes obscure, ulcerates, and allows the aqueous humour to be discharged. The disease generally affects both eyes. From what we know of the origin of purulent ophthalmia, and from some ingenious observations of Mr Gibson of Manchester †, it appears probable, that the origin of this disease is communicated by the lodgement of an acrimonious discharge upon the eyes of the child, from the vagina of the mother. In a great proportion of cases, Mr Gibson found the mothers of those children, affected with purulent ophthalmia, had leucorrhœa; and it is probable, that this, as well as other acrimonious discharges, which we know take place from the mucous membranes of these parts, may produce the disease.

† See *The Edinburgh Medical and Surgical Journal*, vol. iii.

Treatment.—Solutions of saccharum saturni and opium, injected between the eyelids, or the aqua camphorata of *Beates*, ought to be employed in the first stage of the disease; and the eyelids ought to be likewise covered with some mild unctuous application. When ulceration has advanced so as to endanger a rupture of the cornea, that may be prevented by discharging the aqueous humour. In the second stage of the inflammation, scarifying the eyelids, and applying the red precipitate ointment, will generally be found to be useful in allaying the inflammation and swelling of the eyelids, and is restoring the transparency of the cornea.

3. *Of the Gonorrhœal Ophthalmia.*

The gonorrhœal ophthalmia occurs very rarely; and it has been known to arise from the suppression of a gonorrhœa, or from the accidental application of the gonorrhœal matter to the eyes. In this respect, its origin is very similar to the common purulent or Egyptian ophthalmia, and to the purulent ophthalmia which occurs in children.

The symptoms and progress of the disease are also similar, only that its progress is much more violent, and it generally completely destroys the organ.

Treatment.—When it is suspected that the disease has arisen from a suppressed gonorrhœa, such means ought to be employed as are most likely to restore the discharge from the urethra; such as the introduction of a bougie, the injecting of warm oil, and the application of poultices and fomentations to the perinæum. If the inflammatory symptoms run high, powerful evacuants should be employed. Besides purgatives, blood should be taken from the arm or temporal artery.

The local applications should consist of weak injections of corrosive sublimate and opium, or acetate of lead and opium; and the swelling and redness may be also relieved by the application of the red precipitate ointment, or the ointment of Janin.

SECT. II. *Of the Pterigium.*

The word pterigium denotes all those morbid changes in which that portion of the conjunctiva covering any part of the cornea or sclerotic coat becomes thickened, vascular, and opaque. If the disease be confined to a particular part of the conjunctiva, the disease is observed at its commencement like a small globule of fat, or condensed cellular substance, situated most frequently near the junction of the cornea and sclerotic coat; and this spot extending imperceptibly along the surface of the conjunctiva at length passes over the cornea, the conjunctiva on the adjoining part of the sclerotic coat becomes puckered, and as if it were forcibly drawn over the cornea. The portion of it which lies on the sclerotic coat is commonly loose, and can be easily elevated, but that which is on the cornea adheres more firmly. This species of pterigium has generally a triangular form; one of the angles of the triangle advancing towards the cornea, or covering a portion of it, and the base lying on the sclerotic coat. Sometimes the thickening of the conjunctiva is first perceived on the cornea; the conjunctiva covering the sclerotic coat remaining quite sound. A pterigium is always considerably elevated above the adjacent cornea; but the degree of its thickness varies from that of a thin membrane to that of a fleshy mass.

Pterigia arise most commonly at the nasal angle of the eyeball. They are formed, also, at the temporal angle; and they sometimes occur at both places in the same eye. In one case there were two pterigia in each eye. They are formed very rarely on the upper and under parts of the eyeball.

Treatment.—The only mode of removing this disease is by excision. This may be done by elevating the diseased portion of the conjunctiva with a pair of forceps; and separating it at its base by cutting it through with a pair

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pair of scissars; and then carefully dissecting it off to its apex. If any portion of it has been allowed to remain, or if the wound shews any tendency to form a fungus, lunar caustic ought to be applied to it, and the application repeated as often as may appear necessary. Any slight inflammation or weakness in the eye which may continue after the operation, may be speedily removed by the application of the vinous tincture of opium.

Sect. III. *Of Pustules* (Ophthalmia pustulosa).

Symptoms.

Pustules are small tumors which are formed both on the cornea and sclerotic coat, but they occur most frequently near the junction of these membranes. A pustule commonly first appears like a dusky yellow or reddish spot, a little elevated above the surface of the cornea or sclerotic coat; and in a short time it becomes a distinct conical tumor. The adjacent part of the cornea is always more or less dim; and a considerable degree of inflammation accompanies it, which is either confined to the white of the eye contiguous to the pustule, or is spread over the whole eyeball. Whilst the pustule is forming, the inflammation is generally confined to that part of the white of the eye which is in its immediate vicinity. The blood vessels are of a pale livid hue; they appear superficial, and can be readily elevated by a pointed instrument; each trunk can be distinguished, for they are never so numerous as to appear confused, or like one red mass. They sometimes run in various directions, anastomose freely with one another, forming net-works upon the white of the eye.

If the inflammation and pustule remain for some time, the pustule generally advances to suppuration. When suppuration takes place, the apex of the pustule ulcerates, and frequently a chalky white spot appears at the centre of the ulceration; and the opacity of the cornea at the same time daily increases around it. In other cases, the opaque matter separates, and leaves behind it a deep ulcerous excavation.

Sometimes the suppuration proceeds more like a common pimple or phlegmon of the skin; a small quantity of a thick matter collects within the pustule, and when it is discharged, a conical tumor remains, which has a depression at the apex. When the pustule contains a watery fluid, the fluid is most frequently absorbed in a gradual manner; but at other times the pustule breaks, and an ulcer is formed.

If, in either of these cases, the contents are artificially discharged, all the accompanying inflammatory symptoms are much increased.

Most frequently there is only one pustule, and only one eye affected; but in some cases there are several both on the cornea and sclerotic coat of each eye.

The disease, at its commencement, is almost invariably accompanied with the sensation of a mote in the eye, and the whole conjunctiva covering the sclerotic coat has often a yellowish and shining glassy colour before the redness appears. There is often also a degree of redness and swelling, chiefly of the upper eyelid; and the tarsi are found adhering together in the morning, from the exudation of a yellow matter among the ciliæ. There is frequently an unusual dryness felt in the eye; but if it be exposed to a bright light, or if an attempt be made to use it, the secretion of tears is increased.

This species of inflammation is always accompanied with a much greater degree of general fever, in proportion to the severity of the local symptoms, than any other ophthalmia. The pain is rarely acute till the pustule ulcerates; but, if that takes place, it is commonly very severe.

An eye which has been once affected with pustule, is very subject to repeated attacks of the disease. Pustules of the cornea are met with in people of all ages; but they are more common in young people than in those advanced in life.

Treatment.—Sudorific medicines, cooling diluent drinks, and purgatives, ought to be employed in the first stage of the disease; and given according to the violence of the constitutional symptoms. The eye, and parts around it, should be fomented three or four times a-day, with a decoction of poppy heads; to which may be added a small quantity of spirits. When the symptomatic fever abates, and the redness assumes a more purple hue, the vinous tincture of opium may be applied to the eye once or twice a-day; and this will be found equally useful whether the pustule is in a state of suppuration or not; and it ought to be continued as long as there are any remains of the disease.

Sect. IV. *Of Matter collected between the Lamellæ of the Cornea.*

Purulent matter is sometimes collected between the lamellæ of the cornea, when the disease is termed *unguis* or *onix*; or in the anterior chamber, when it is called *hypopion*.

When the matter is collected between the lamellæ of the cornea, it appears in the form of a yellow spot; and as the quantity increases, the spot becomes larger, but does not alter its situation from the position of the head.

When the matter is collected in the anterior chamber, it generally appears like a small yellow globule between the iris and cornea, occupying the inferior part of the cavity. These abscesses are commonly the effect of violent ophthalmia, occasioned by a blow, or injuries of the eyeball; they are also formed, though rarely, without any accompanying inflammatory symptoms.

Treatment.—Though the purulent matter may be more or less absorbed on the abatement of the accompanying inflammatory symptoms; yet it would be found a good general practice to evacuate the matter whenever it apears, by making an incision through the cornea. The discharge of the aqueous humour along with the matter, never fails to diminish the inflammation; and this perhaps may be the reason why the practice is so useful. Besides this, fomentations, brisk purges, and cupping at the temples, may be necessary if the inflammatory symptoms are severe.

Sect. V. *Of Ulcers of the Cornea.*

Ulcers of the cornea have been divided by some authors into a number of species, from differences in their size, in their duration, in the degree of the severity of the accompanying symptoms, and from the various causes from which they have been supposed to originate.

The most frequent variety of ulcer is that which remains after the cornea has suppurated and burst; either in consequence of a pustule or of an abscess.

When a pustule suppurates, the central part of it generally

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nerally gives way; and as the disease continues, the ulceration extends in all directions from that point. Ulcers of this kind are generally circular, and the edges rounded and smooth; having sometimes the appearance of a small artificial dimple: in other instances they have an irregular shape, and their edges are jagged and acute. The size of ulcers is very various; in some cases they do not appear larger than a depression made by the point of a pin, whilst in others they cover a large surface. Most frequently the part of the cornea contiguous to the ulcer becomes more or less dim; and in some cases red vessels may also be traced in it.

Treatment.—The acute pain which generally attends most ulcers, particularly those which are the consequence of pustules, will generally be much relieved by the application of the vinous tincture of opium, repeated two or three times a day. When this produces no good effect, and the ulcer spreads rapidly, attended with acute pain, much relief will be obtained by touching the surface of it with lunar caustic, or if there is a risk of the ulcer eroding the whole thickness of the cornea, and a prolapsus of the iris to take place, it may be advisable to prevent this by discharging the aqueous humor.

Sect. VI. *Of Specks of the Cornea.*

There are three forms of the corneal speck; the *first* and most simple variety, is when a particular part of the cornea loses its natural transparency, and appears clouded; objects being seen by the patient as if looked at through a mist or smoke. Some of these specks are undefined, others distinctly circumscribed, and they have each an equal degree of opacity throughout, or one part is more opaque than the rest. They are most commonly of a circular form; but in some cases their shape is very irregular. This size varies from the smallest spot, to such an extent as occupies the whole cornea.

In the *second* form of the corneal speck, the opacity is of a darker shade, giving the cornea a bluish, or in some parts a milky appearance. It is seldom equally opaque through its whole extent; being generally more so at the centre, and becoming gradually of a lighter shade towards the margin. In some instances the shade is very unequal in the different parts of the speck.

In the *third* form of the corneal speck, the cornea becomes of the opaque glistening white colour of common pearl, and the opacity generally extends through the whole of the lamellæ of the cornea; so that if even several of those layers which are external be removed, the remaining ones completely interrupt vision. Specks of this description sometimes produce a slight thickening of the cornea and are accompanied by adhesions between the cornea and iris. They are almost always distinctly circumscribed, though generally not so opaque at the edge. When they are of any considerable size, they are nourished by one or more red vessels.

In the first form of speck, the iris can be seen through the diseased portion of the cornea; but in the second and third form of the disease, the degree of opacity is such, that nothing can accurately be distinguished behind it. If there is an external inflammation accompanying the speck, the red vessels will be seen in a cluster on that part of the sclerotic coat nearest to it; and some of the branches can often be traced passing over the edge of the cornea, and terminating in the substance of the speck. As the accompanying inflammation abates, the number of the red vessels on the cornea commonly diminishes; but sometimes one or more trunks remain, and are distributed on the speck. In some cases, there are large specks with numerous blood-vessels supplying them during the continuance of active inflammation; and although the opacity remains extensive after the inflammation abates, yet no red vessels continue to nourish it. The number of blood-vessels is in no case in proportion to the degree or extent of the opacity during any stage of the accompanying inflammation. For we frequently observe a net-work of blood-vessels on a cornea which has very little obscurity, and at other times there is a large opaque spot, with only one, or even without a single red vessel supplying it. Specks appear on every part of the cornea, but most frequently towards its centre.

Specks appear to be formed most frequently on the external lamella of the cornea; but it is difficult to determine accurately their situation. They vary in number. Commonly there is only one; but it frequently happens that there are two, three, or more distinct spots on one cornea, all of which differ in their size, shape, and in degree of opacity.

Specks impede vision in proportion to the degree of their obscurity, and according to their situation. Even a speck of the slightest shade, which is hardly perceptible to a common observer, if it be placed directly opposite the pupil, materially injures the sight; whereas those of the opaque kind, if placed beyond its circumference, diminish the sphere, but not the distinctness of vision. In those cases where the speck is of a moderate size, and placed towards the centre of the cornea, the patient sees better in a dull, than in a clear light. For in a clear light the pupil contracts so much, that it becomes covered by the speck, and the rays of light are prevented from entering; but in a dull light it becomes larger, so that the rays of light enter by its edge.

Specks, most commonly, are either preceded or accompanied by inflammation of the cornea. Likewise wounds, if they do not unite without suppuration, and ulcers of the cornea, are followed by a speck.

Specks are formed at every period of life; but they occur most frequently in young people; probably because in them the cornea is much softer, and more spongy; and also as they are more subject to inflammatory complaints of the eye than adults.

Treatment.—Those specks which have been described under the *first* and *second* form of the disease, generally disappear either by the use of remedies, or in some cases after the inflammatory symptoms abate.

When the eye is inflamed, and the eyelids turgid with blood, slightly scarifying the eyelids, and immediately after the bleeding ceases, applying a quantity of an ointment composed of the red oxide of mercury (ten grains to a dram of simple ointment), will be found a very active remedy. And the scarifications along with the ointment should be repeated every second or third day as long as any inflammation continues. When there is no inflammation accompanying the speck, the ointment may be applied alone. The unguentum citrinum, and various powders composed of the sulphate of alum, sulphate of zinc, sub-borate of soda, diluted with from a fourth to an eighth

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eighth part of sugar, may also be advantageously employed. In specks of long duration, it will be found useful to vary the application, and to employ two or three of the above medicines ten days or a fortnight alternately.

Those specks of the *third* form, seldom become more transparent, even by the use of the most active remedies. In those cases where only a small central portion is of that description, the size of the speck may be diminished by the treatment already mentioned; and in some cases, much benefit has arisen from cutting away an external layer of the most opaque part; and afterwards using the above applications. It often happens, however, that if portions of a very old and opaque speck be cut away, the part is regenerated by an equally opaque matter.

The specks which are formed rapidly, are in general most speedily removed. They go away, too, much more quickly in children than in old people; and in them, also, a much greater degree of obscurity can be made entirely to disappear. When a part of the cornea has become opaque, the opacity begins to disappear at the circumference of the speck, or at that portion of it nearest to the circumference of the cornea. In some cases it may also be observed, that the external laminæ of the cornea first regain their transparency.

Sect. VII. *Of the Staphyloma.*

When the cornea, besides losing its transparency, swells to such a degree, that its internal surface comes in contact with, and adheres to the iris, and when it forms a prominent tumor externally, the disease has generally been called *staphyloma*. When the whole cornea is affected, it generally assumes a more or less conical form; loses entirely its natural transparency; and vision is completely destroyed. The opacity is generally most remarkable towards the apex of the tumor, and is generally of a pearl white colour diffused through the whole corneal substance. The internal surface of the cornea adheres to the iris, and the pupil is in most cases altogether obliterated.

In many cases the cornea does not project beyond the eyelids: but in others, particularly in children, a large tumor is formed, which projects beyond the eyelids, and is attended with pain and inflammation, which, in some instances, renders the other eye weak and irritable.

Treatment.—When a part of the tumor gives way, and allows the contents of the tumor to be discharged, the patient always experiences a speedy relief, but the tumor is soon formed again; so that in order to prevent its growth, it is necessary not only to discharge its contents, but also to remove a portion of the diseased cornea of such a size as to prevent the humors from again collecting. A common extracting knife may be passed through the tumor, so as to divide a segment nearly equal to half the cornea, and the other half may be readily cut away with scissars. Inflammation and suppuration succeed; and the eyeball finally collapses if there be not a sufficient degree of inflammation excited. A pointed instrument may be introduced through the wound, so as to allow the crystalline lens, or any portion of the vitreous humour which may have remained, to be pressed out.

Sect. VIII. *Of Inflammation of the Iris.*

Inflammation seldom affects the iris alone, though in some cases it appears to be the principal diseased part of the organ. The disease is accompanied with intense pain on exposure to light; discoloration of the iris from the addition of red blood; disposition of the pupil to contract; and lymph to be effused on the surface of the iris and pupil.

Treatment.—Copious bleedings from the arm, or temporal artery, are generally necessary; and in order to prevent any permanent contraction of the pupil from taking place, much benefit will be derived from keeping it dilated by the action of an infusion of *belladona.*

Sect. IX. *Of the mode of Making an Artificial Pupil.*

The iris, whether from previous inflammation or other cause, has been often found with the pupil so much contracted, and adhesions formed between it and the capsule of the crystalline, to such a degree, as to prevent vision. The pupillar edge of the iris, too, sometimes adheres to the cornea, and is contracted; and sometimes a portion of cornea opposite to the pupil is a cause of blindness. In all such cases it has been repeatedly attempted to make an artificial pupil; but this operation has seldom been successful. Various modes have been proposed to perform it, but that recommended by Scarpa is entitled to most attention. This method consists in introducing a curved couching needle (Plate DXVII. fig. 20.), as in the operation of couching the cataract, passing its point through the iris at the place where it is intended the new opening should be made, and then forcibly tearing down a portion of iris from its connection with the ciliary ligament. After the operation it will be found useful to keep the iris for some time under the influence of belladona. We understand that Mr Gibson, an ingenious surgeon in Manchester, has operated with great success in a new manner. He makes the punctuation of the cornea at its transparent part with an extracting knife (Plate DXVII. fig. 1.), and presses the eyeball so as to squeeze the iris through the incision of the cornea; or if any adhesions render that impracticable, he drags it out with a hook (Plate DXVII. fig. 19.), and afterwards cuts away with a scissars the prolapsed portion. Then immediately the perforated iris falls back into its natural situation, leaving a proper opening.

Sect. X. *Of the Cataract.*

The most common disease of the lens is a loss of its natural transparency; and this arises either from a change in its structure, or from a deposition of new matter. The capsule of the lens is also subject to opacities. These diseases are known by the name of *cataract.*

There are *four* species of cataract generally enumerated. In the first, the crystalline lens itself becomes opake (*cataracta crystallina*). In the second, the capsule is changed in its structure (*cataracta membranacea*). In the third, the liquor Morgagni becomes opake (*cataracta interstitialis*); and when all those parts are affected at the same time, it has been denominated the mixed cataract, (*cataracta mixta*).

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Consistence of cataracts.

When the crystalline lens becomes opake, the opacity generally begins towards the central part of the lens, and extends towards its circumference; in other cases a general obscurity extends over the whole lens.

The consistence of the lens varies very much in the different kinds of cataract. Sometimes it is converted into an aqueous or milky fluid, or like thin jelly; at other times it becomes harder and firmer than natural; and in several cases it has been found converted into bone, or into a chalky looking substance. It has been generally remarked, that the fluid or milky cataract is most frequent in children, but we have also met with it in those advanced in life. The solid or concrete cataract, on the other hand, has been generally found in adults. At the same time, we have observed the lens of young people converted into a hard and white substance resembling chalk.

Colour of cataracts.

The colour of different cataracts is very various; and they never appear of the same colour in the eye as when removed from it. The most usual colour of them in the eye is a bluish white or gray; sometimes clouded in different parts or striated, sometimes of a lead colour, sometimes greenish, and sometimes of a yellow or amber colour. When taken out of the body, those which appeared white or gray are generally dark yellow or amber; and those of a yellow tinge in the eye often appear white when extracted.

Diagnosis between hard and soft cataracts.

There is scarcely any diagnostic mark of a soft and hard cataract which can be altogether depended on. The colour proves nothing, those of a milky colour being often quite hard, and sometimes those of a pearl colour are quite soft. Neither is there any thing to be learnt from the degree of the opacity; for it will be found that those who see no more than to be able to distinguish light from darkness have the lens quite soft, whilst those who can distinguish colours and large objects have the lens quite hard. Richter, however, has remarked two symptoms, which he says have seldem deceived him in ascertaining this point. The softer the lens is, the larger and thicker it is in general, and therefore approaches nearer to the plane of the iris or to the edge of the pupil. Hence he always concludes that the cataract is soft when it is near the pupil. In order, however, to judge of the space between the pupil and lens, the surgeon must look into the patient's eye from one side; and in general it requires much experience to judge of this with accuracy.

We are also able, in some cases, to discern points, streaks, or inequalities, in the shade of a cataract. If, after having observed the place, figure, and disposition of them, we find that in some days afterwards, or upon rubbing the eye pretty hard, they have undergone any change in their figure, situation, or shade of colour, we may then conclude with certainty that the cataract is soft; only we must be cautious not to draw an opposite conclusion, viz. that we are not to conceive the cataract to be hard if these changes should not be perceptible.

"A perfectly *hard* cataract," says Beer,* "shows itself very plainly before the operation; the pupil is equally opake in its whole circumference; there are not to be observed any points, streaks, or spots, of a clearer or darker colour; the lens is evidently separated from the iris, so that a sufficient number of rays of light can enter, and the patient is still capable of distinguishing some objects from the side of the eye; the motions of the pupil are extremely lively, and it never remains considerably enlarged. The opacity behind the pupil at the commencement of the disease is first observed in the middle, and it then extends, but very slowly, towards the circumference. Such patients, if the middle part of the pupil is completely opake, can for the most part read writing by the assistance of a magnifying glass, and distinguish small objects. The colour of the hard cataract is gray, passing more or less to a greenish hue; and the smooth level of the lens may be very plainly remarked."

* See *Bemerkungen, uber den Grauer Star.*

Cataract generally a local disease.

In most patients the cataract is to be considered as a local disease, though there are also many cases where an opacity of the lens comes on after or along with other diseases of the eye. It has been observed in gouty and rheumatic constitutions, and in such people there is reason to suspect that it is more or less connected with the general constitutional affection. This observation is of importance; for when an operation is performed in such cases, a total blindness is usually the consequence. Richter operated on a man who had been much troubled with gout, and his sight was restored. In seven months afterwards the pupil gradually contracted, at last closed, and a second blindness followed. In one case of a similar kind on which we operated, an attack of gout succeeded the operation, the eye suppurated, and the inflammation has never altogether disappeared, though two years have elapsed since the operation. Even in such cases the operation is not to be entirely forbidden: the success is less certain, and the patient will require a very careful preparation before it, and much attention after it.

Hereditary cataract.

There are some varieties of cataract which are considered to be hereditary. Richter extracted a cataract from a man whose father and grandfather were both blind from that complaint. Maitre Jean and Janin have both met with similar cases. Richter also saw three children, born of the same parents, who had all cataracts at the age of three years. We have known several similar facts, and particularly one of twins, who both were affected with cataract when one year old.

Cataract of the capsule.

When the cataract is seated in the capsule above, it in general arises from a blow or wound with a pointed instrument. Sometimes the whole anterior portion is opake and very much thickened, whilst that which is posterior remains transparent; and in some cases the capsule has been extracted in the form of a bag, having become altogether opake, and containing within it the crystalline. Such cases have been called by Richter the *cataracta cystica.* He says he has only met with one case of that form of the disease; Beer, however, mentions many; and from meeting with them he has been led to propose the extraction of the capsule along with the crystalline in all cases of the disease.

The *cataracta membranacea primitiva* of Scarpa is also another form of the disease. In this variety the lens disappears, and leaves the capsule opake, or at most in its interior a speck not larger than a pin-head. This kind of cataract, Scarpa remarks, occurs most frequently in infants, or in people under twenty years of age. It may be distinguished by its resemblance to a very thin scale, or by a very white point, at the centre or at the circumference of the crystalline.

Trembling cataract.

The *tremulous* cataract (*cataracte tremblante* of the French), is another variety of the disease which deserves to be noticed. It is generally of a very opake white colour,

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colour, and seldom large. It moves about on every motion of the eye, and the whole iris trembles and fluctuates to and fro. Sometimes they altogether disappear, at times passing behind the iris, but they soon regain their situation. In one example of this disease we observed that the opake lens sometimes fell into the anterior chamber through the pupil. In this form of the disease it generally happens that the functions of the retina are impaired or lost; though this is not always the case.

Cataract combined with amaurosis.

Cataract is often accompanied with a complete amaurosis. In some cases of this kind there is a great dilatation and immobility of the pupil, and the opake lens is observed of a very large size behind it. The patient can seldom distinguish light from darkness; and the want of sight generally precedes any obscurity of the lens. In some cases, where there is a combination of cataract and amaurosis, the pupil remains of its natural form, and alters according to the quantity of light. But, as in the former variety of the disease the opacity of the lens most commonly precedes the amaurosis, it generally too comes on suddenly, preceded by sparks of fire appearing before the eyes, or clouds flying before them, or headach, and pains about the brow or temples. We have seen an instance of a simple cataract in one eye, and in the other cataract and amaurosis combined.

Commonly cataract affects both eyes simultaneously; but there are also many examples of the disease affecting only one eye. It also happens, that first one eye is affected, and many years afterwards the second. We have in general observed, that when the cataract takes place only in one eye in young people, or when it succeeds a blow, the other eye is seldom affected. But on this we should not trust much, for it is an undeniable fact, that a great sympathy exists between the two eyes; and that when one of them becomes diseased, the other is very apt to become similarly affected. We have seen a case where a staphyloma arose in one eye in consequence of a wound, and in a few years afterwards the other eye became staphylomatous. A man who received a blow on one eye, which produced amaurosis, had soon afterwards a cataract formed on the other. Richter mentions an analogous case. St Ives mentions a very remarkable case of a man who was wounded in the right eye with a small shot, and shortly after that eye was affected with a cataract. Some time afterwards the same disease took place in the left eye, but which gradually disappeared after the cataract had been extracted from the *right* eye. These observations on the connection between the two eyes, have led some surgeons to advise operating for cataract when only one eye is affected, in order to prevent the second eye from becoming diseased. There are a few cases where this practice has been successfully adopted, and there are others where it has failed. We know of one gentleman, now upwards of seventy years of age, who was couched for a cataract in one eye when twenty years old, and the disease has never attacked the other eye. Richter once performed the operation on a woman who had a complete pearl-coloured cataract in the *left* eye, and an incipient one in the right, which, before the operation took place, was beginning to advance rapidly. After operating on the left eye, the progress of the disease in the *right* seemed to be checked, and for years after the operation it had not made the smallest progress. On the other hand, we have operated in several cases where the disease was just commencing in one eye, and when the operation did not appear to arrest its progress in the second one. It is therefore a point not yet determined in what cases it would be advisable to operate when only one eye is affected; for in those where the progress of the disease in the second eye cannot be arrested by an operation on the first, no operation should be performed on either eye until vision is nearly altogether destroyed.

Progress of the disease.

The progress of this disease is very various: sometimes it proceeds so slowly as not to destroy vision for many years; at other times a complete obscurity of the lens has been known to take place almost instantaneously. Richter and Eschenback both relate cases where people labouring under gout, which suddenly retroceded, were entirely deprived of their sight in one night. We have observed analogous cases, though we could not determine the existence of any constitutional affection.

From the sound crystalline being chiefly composed of *albumen* and a small quantity of *gelatine*, whatever might produce a coagulation of these, would destroy the pellucidity of the lens. Whatever too would produce inflammation of the capsule of the lens might also render it obscure; for when any serous surface is inflamed, and to that class belongs the capsule of the lens, its transparency is destroyed, and it becomes thickened from an effusion of albuminous matter on its surface. Cataracts arising from wounds are probably produced in this manner.

In old people there is often distinguishable a slight obscurity of the lens, and sometimes it even forms a complete cataract. In such cases the obscurity probably arises from a want of balance in the secreting and absorbent systems, or the necessary perfection of these functions to preserve the natural state of parts, which we observe to decay in many other organs, as well as the eye, in those far advanced in life.

Symptoms remarked by the patient.

Besides the symptoms which are to be observed in an eye affected with cataract, there are others remarked by the patient. Objects appear to him as viewed through a mist or cloud; and as the opacity of the lens increases, the cloud appears greater until it finally prevents even the largest objects from being distinguishable.

The patient, at the commencement of the disease, can distinguish objects better in a moderate than in a bright light; and the same thing happens if the light be interrupted by the interposition of the hand or any other shade. The reason of this is obvious; because the pupil is more dilated in a moderate than in a bright light, and thus still admits a certain number of rays of light by means of the pellucid circle of the lens.

When the exterior part of the lens is less obscured than the centre, the patient sees those objects much better which are placed by his side, than those which are opposite to him.

If the obscurity has not affected the middle of the lens, but some part of its edge, any circular body looked at by the patient, appears to have its edge imperfect. It has been also remarked that some patients see every thing with perforations in them. The cataract is seldom accompanied with any pain. When it is brought on from internal causes, both eyes are generally affected.

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Of the Treatment of Cataract.

In the treatment of cataract, recourse has generally been had to a surgical operation. Some have pretended to cure cataract by internal medicines. Small doses of *calomel*, *electricity*, *extractum hyoscyami*, *aqua laurocerasi*, have been extolled; but their use is now very generally given up. In some cases of cataract which have arisen from an injury of the eye, Mr Ware has seen them disappear by an external application of æther, which promoted the absorption of the opaque body *.

There are two operations which have been proposed for the cure of the cataract; the one called *extraction*, and the other *couching*. In the first, an incision is made into the cornea, and the lens removed by pushing it through the pupil. In the second, the lens is taken out of its capsule, and lodged in some part of the vitreous humour, where it may be entirely out of the axis of the eye. Each of these methods has been much practised; and though a decided preference seems at present to be given by the most distinguished surgeons to the mode by extraction, yet there are also cases attended with peculiar circumstances, in which the operation of couching may be successfully employed. Both operations ought therefore to be well understood by every surgeon.

* See his *Surgical Operations.*

Preparatory steps.

It was formerly the custom, before performing either of these operations, to confine the patient for several weeks, or even months, to a strict antiphlogistic regimen; but this precaution, except in very particular cases, may be generally dispensed with. People who have become blind, generally lead a quiet life, and are not exposed to any of those dissipations which are likely to affect the constitution. It will therefore generally be found sufficient precaution, before attempting an operation, to enjoin the patient to live moderately; to avoid spirituous liquors, and take a few doses of any of the common laxative medicines. If he be strong and plethoric, it will be necessary to pursue such a course a little further; to give doses of laxative medicines for a longer period, and even to bleed the patient in the arm. Many surgeons lay it down as a general rule, to take some blood on the morning of the day of the operation, either from the arm, from the temples, or from the neck by cupping; and either of these methods is to be preferred, according to the quantity of blood which is intended to be taken. In old people of a healthy constitution, we have often found it unnecessary to use any of these means, no inflammatory symptom having arisen during the progress of the cure. In many cases, instead of bleeding before the operation, we have preferred doing it after the operation was performed, when the patient was put quiet in bed. Blood taken at this period may be reasonably supposed to have a more powerful effect in giving check to any inflammatory attack which might be apt to succeed the operation, than if an equal quantity had been taken away before it. The bleeding too, immediately after the operation, we have often observed, renders the patient calm, and more disposed to rest, whereas at the same time any of those disagreeable symptoms are avoided during the operation, which are apt to remain for several hours after bleeding, when the patient is in the erect posture. It is also of importance before the operation is performed, the patient being so situated, that he can be easily put to bed. The operation should therefore be performed in the same chamber in which he is to remain, or in one immediately adjoining; and he should be clothed in a bed-gown or some loose dress, so as to enable him to get into bed without much trouble. The bed should be placed in such a position in the room that the light does not fall directly on the patient's face, so that during the cure, all glaring lights may be easily avoided.

Of the Extraction of the Cataract.

In this operation the object of the surgeon is to make a wound in the cornea, and to extract through it the opake lens. In performing it there are four steps which require to be particularly considered. The *first* of them is the means to be employed for securing the eye during the operation. The *second* is the mode of making the incision through the cornea; the *third*, the mode of opening the capsule of the crystalline lens; and the *fourth* is the extraction of the lens. All these shall be considered separately.

Mode of securing the Eye and Eyelids.

One of the great improvements in modern surgery is the simplicity of the mechanical means employed in performing operations. A great variety of contrivances have been proposed, in order to secure the eyeball and eyelids during the extraction of the cataract. Experience, however, shows, that almost all these are completely useless, and most of them extremely hurtful. To dispense, therefore, with these instruments, and to be able to execute with the fingers alone those parts of the operation for which they were employed may be justly considered as a material improvement. The eyeball and eyelids may be completely secured in almost all cases, by the fingers of one hand of the operator, and those of an assistant. The assistant will generally find that, with the fore finger of one or of both hands placed upon the tarsus, one upon the internal, and another towards the external angle of the eye, he will be easily able to raise the upper eyelid, so as to expose the cornea; and by the finger being placed towards the internal angle he will be also able to assist the operator in preventing the eyeball from being turned inwards, when the incision into the cornea is about to be made. The operator is to secure the under eyelid by the fore and middle fingers of his left hand. They are to be placed in such a manner over the edge of the tarsus, that they may come in contact with the eyeball; and the middle finger is to be pressed pretty firmly in the internal angle of the eye, between the eyeball and lachrymal caruncle, so as effectually to prevent the motion of the eye towards the nose. In this position of the fingers of the operator and assistant, those who are accustomed to perform operations on the eye, find that they are completely master of the motions of the eyeball; and by altering the positions of the points of the fingers, and applying more or less pressure, they are able to counteract any untoward motion of the organ. Before attempting to secure the eyeball, the operator should be prepared to advance in every step of the operation; for it will be generally found, that if an attempt has been made to open the eyelids forcibly, a certain degree of irritation and watering of the eye takes place; so that, when a second attempt is made, with

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with a view of proceeding to the other steps of the operation, more difficulty is met with in holding the eye than at first would have been the case. It is a good precaution, however, for the surgeon to take an opportunity, before the day of the operation, to try to fix the eye, and to explain to the patient this step of the operation; for it often happens, that patients start, and make great resistance by squeezing the eyelids, when the operation comes to be performed; so that by habituating them to the mode of securing the eye, it is more easily accomplished. The first thing to be attended to, before attempting to fix the eye, is a proper light, the position of the patient's head, and the height of the chair in which he is to sit. The light of the room should come from one window, and the patient sit in such a manner that the light falls obliquely over his nose upon the eye to be operated on. If he be placed so that the rays of light from the window fall in the direct line of the eye, the surgeon will find that he is obliged, either to sit in his own light, or that the reflections upon the cornea tend to embarrass him. As soon as the other eye is covered, so as to prevent it from having any motion, and communicating that motion to the eye on which the operation is to be performed, the assistant is to be placed behind the patient, and the patient's head to be supported firmly on his breast. The height of the chair on which the patient is to be placed, will depend on the height of the patient, and always should be so low, that the assistant is able to look over the head, and completely command the motion of his own fingers. The operator and assistant should open both eyelids at the same time, which will more readily secure the eyeball in a proper position. The eyeball, however, is apt to be turned upwards, so that the cornea is thrown out of view. When this happens, the upper eyelid should be first raised, and the assistant should be always ready with the points of his fingers, to press in such directions, that when the eyeball at any moment places itself in a proper position, he may be ready to secure it. When, on the other hand, the eyeball is thrown downwards, the operator himself must place it in a proper position, and in this manner both the operator and assistant are to co-operate with each other, and the one or the other placing his fingers in such a manner as to counteract most effectually any awkward position of the eyeball. When the eyeball appears steady, the incision of the cornea ought to be immediately performed. But before entering the knife, it will be found a useful precaution to touch the cornea frequently with its back, and see if the patient starts, or if the eyeball remains quite steady. It will often happen, that whenever the point of the instrument touches the eyeball, it is suddenly thrown into motion; and was the incision of the cornea to have been begun at this moment, much difficulty would have arisen. If, however, the eye be repeatedly touched with the knife, the starting motion will sooner or later cease, and then the incision of the cornea may be begun with every possible advantage. When the knife has passed through both sides of the cornea, there is no danger of any motion of the eyeball hindering the operation.

It sometimes happens that the eye is extremely small, and that it is sunk deep in the orbit. In such people the operation becomes much more difficult; and we have met with cases, where, from these circumstances, it was almost impossible to secure the eyeball with the fingers; the room which the fingers necessarily take preventing the knife from being properly managed, and covering a portion of the cornea. In such cases, the speculum contrived by M. Pellier will be found to be a useful instrument. See Plate DXVII. fig. 8. The speculum consists of a piece of silver wire, bent in the manner represented in the plate; and though in itself extremely simple, it requires a good deal of management and nicety in using it. The curved edge of the wire (*a*) is to be placed upon the inside of the *ciliæ* on the horizontal plate of the tarsus; the skin of the upper eyelid being previously stretched upwards. The assistant is then to move the speculum upwards, imitating, as it were, the natural motion of the eyelids; and, when the eyeball is sufficiently exposed, the speculum, with the handle (*b*) resting on the brow of the patient, is to be kept firm and steady in the same position. In using the speculum, it is necessary to make a considerable pressure on the eyeball, in order to prevent the eyelid from slipping from underneath the speculum. At the same time as little pressure should be employed, as will prevent this from taking place. Many surgeons, in using the speculum, place it behind the *ciliæ;* and whenever any watering of the eye takes place, from the irritation of the instrument, it is very apt to slip from the moisture of the skin. In order to prevent this, we have found very material benefit from simply folding round the speculum a thin fold of crape, which, from its roughness, effectually prevents the risk of the speculum slipping. The operator is to manage the under eyelid in the same manner as if the upper eyelid was covered by the fingers of an assistant; and it more particularly rests with him to prevent the eyeball from rolling inwards, the speculum merely serving to support the upper eyelid.

After the knife has penetrated both sides of the cornea, the assistant is to be aware that no pressure is to be made upon the eyeball. When, therefore, this step of the operation is completed, the assistant, if he be using the speculum, is to be particularly careful in taking off any pressure which it may make, and merely to support the eyelid.

Mode of making the Incision of the Cornea.

The great object to be kept in view in making an incision of the cornea is, that it be of sufficient size to allow the easy extraction of the crystalline lens, and that any cicatrix which may remain may not interrupt the entrance of the rays of light through the pupil. The mode which has been recommended to effect these purposes, is to make a semicircular incision, parallel to the circumference of the cornea, and about half a line distant from the junction of the cornea and sclerotic coat. One of the knives (Plate DXVII. fig. 1, 2, 3.) is to puncture the cornea half a line distant from its circumference, to be carried across the anterior chamber to the opposite side, and brought through the cornea at the same distance from the sclerotic coat to where it was entered; afterwards the incision is to be finished by pushing the knife forwards till the incision is completed.

Instead of making the incision in this manner, Mr James Wardrop has proposed another form of incision, in order to remove several objections to which the former operation was liable *. The disadvantages which Mr Wardrop

* See *Edinburgh Medical and Chirurgical Journal*, vol. iv.

drop supposes to arise from the usual mode recommended are,

1. The cornea being of very considerable thickness, a great part of the semicircular incision will be carried through between its laminæ, and therefore the length of the incision of the internal lamina will be much less than that of the external one. This he explains by two plans, Plate DXVII. fig. 11. and 12. where besides the external form of the incision (*aaa*), there is drawn a second line (*b*), intended to represent the incision of the internal lamina. The dark space, therefore, included between these two lines (*b* and *a*) is intended to represent that portion of the incision which is made between the laminæ.

2. The external form deceives us in the extent of the internal incision, and much more difficulty is met with in bringing the lens through it, than from its apparent length could have been expected; for, as the line of the internal incision has a very slight curvature, the thickness and tension of the cornea admit the edges of the wound to be separated only a little way from one another.

3. When the cornea is divided nearly at its union with the sclerotic coat, and when the aqueous humour and lens have escaped, the portion of the iris opposite to the centre, and most depending part of the wound, loses its natural support given to it by the cornea, and is pushed forward, so that it comes in contact with the cornea, and even insinuates itself between the edges of the incision. The greater the opening is, the more danger there is of a prolapsus, both of the iris and vitreous humour; for it would seem as if these two parts of the eye were pushed forwards in consequence of the contraction of the coats of the eye, which takes place as soon as the incision is made; and if two-thirds of the cornea be cut, there is certainly much less resistance than when the half only has been divided. Thus, the iris and cornea form permanent adhesions in consequence of the inflammation which always follows the operation. The pupil becomes of an irregular form, is drawn from the centre of the eyeball; is sometimes very much contracted, and retains but a very limited sphere of contraction and dilatation.

4. The contraction of the muscles of the globe of the eye pressing forward the contents of the posterior chamber, are very apt to push a portion of the vitreous humour through the pupil and wound of the cornea. When this happens, the pupil becomes irregular, and drawn down towards the incision, the form of the eyeball is somewhat altered, and the prolapsed vitreous humour inclosed in its capsule, appears externally in the form of a round transparent tumor.

5. As the external edge of the semicircular flap of the cornea is very thin, and lies loose, the smallest movement of the eyelids, particularly of the upper one, is apt to catch and raise it out of its proper situation, and thus that speedy union is prevented which would take place if the two divided surfaces had been kept in accurate and constant contact.

6. and lastly; As the internal edge of the incision is often unavoidably made, from the smallnes of the anterior chamber, and the flatness of the cornea, nearly opposite to the inferior margin of the pupil; and as all the extent of the cut surface *ab* (Plate DXVII. fig. 12.), sometimes remains opaque after the wound is healed, the opacity of the cicatrix must diminish the sphere of vision.

All these disadvantages in the usual mode of making an incision of the cornea, appeared to Mr Wardrop to arise chiefly from the want of a sufficient portion of the cornea being left at the inferior part of the wound, to support the iris, and to prevent the pressure of the parts contained within the eyeball, and the occasional action of the muscles pushing forward the iris towards the wound of the cornea; he therefore conceived that if the incision could be made in such a manner that a larger portion of the cornea could be left at the inferior part of the wound, being at the same time made of such a form as to allow the easy extraction of the cataract, and the cicatrix not afterwards to interfere with vision, a considerable improvement would be made in the operation. With this view he made the incision in the following manner.

Of the cornea knife.

The best knife for the purpose is of the same size and shape with that delineated in Plate DXVII. fig. 1. The blade is of a simple triangular form, the back being one continued line with the handle, except merely the point. The point, though extremely sharp, should be made firm, and the blade should turn gradually thicker from the point towards the handle. The point of the knife must be sharp on both edges for at least the breadth of a line, in order that it may penetrate the cornea quickly and easily. The back of the knife should not be left angular, but the edges rounded off and made smooth, so that it be convex on both sides. Particular care ought to be taken that the point of the knife be well conditioned; and it is not only necessary that it be sharp, but that the metal of which it is made be neither too hard nor too soft. This may be easily ascertained by pressing the point upon the nail; for if it bend readily, not being so brittle as to break through, and sufficiently elastic to recover the straight line, we may be confident that it will answer the purpose. It is also a good precaution to have the knife sharpened the day before, or the morning of the operation; and in case of any accident happening to the point, the operator himself should carefully examine by trying how it penetrates a thin piece of leather, immediately before using it. From the point of the knife being too brittle, we have known a case where the point of it was broken off, when attempting to penetrate the inner part of the cornea; and from the point being too soft, we in one case, after puncturing the cornea, found it impossible to penetrate with the knife the opposite side, and this we found had arisen from the point of the knife bending round.

Having previously smeared the knife with oil, or smoothed the edge of it upon the palm of the hand, in order to make it cut more keenly, its point is to be thrust through the cornea at its transverse diameter, and at least half a line distant from the sclerotic coat, and in a direction as if it was to wound the iris, or nearly perpendicular to the spherical surface of the cornea (see Plate DXVII. fig. 13. and 15. *a*). When the point of the knife reaches the plane of the iris, it is to be turned towards the opposite side of the cornea, by moving the blade upon the incision already made, as a fulcrum. It is then to be carried forward, so that the cornea is again punctured at its transverse diameter *b*, at the same distance from the sclerotic coat at which it had been entered on the

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the opposite side (fig. 13.) By these two incisions the blade of the knife has cut perpendicularly, or very nearly so, to the spherical surface of the cornea, and the gradual thickening of the knife, by filling up the wound as fast as it is made, prevents any of the aqueous humour from making its escape. The eye is now completely secured with the knife, and the assistant who has been supporting the upper eyelid, should receive a signal from the operator, to take away all pressure from the eyeball, and merely to support the eyelid sufficiently to allow the inferior half of the cornea to be seen. When the knife has been pushed forward a little way, as is represented in fig. 15. the incision is to be finished by turning round the blade on its axis, and thus keeping the edge turned outwards, in such a manner, that the remaining part of the incision is made a straight line, and therefore nearly perpendicular to the lamellæ of the cornea (fig. 13. *c*). Whenever the last step of the operation is begun, the aqueous humour begins to escape, which allows the knife to cut the cornea readily and in any direction.

Supposing, therefore, that the cornea, instead of being spherical, were a plain surface, the incision now described would be represented by the lines *a*, *b*, and *c*, fig. 13.; but as it is a segment of a sphere, the form will more resemble that represented in fig. 14.; at least this is the form of the incision which the operator should have in view when performing the operation. By the inspection of these figures (13 and 14), it appears,

1. That a large portion or ring of the cornea is left attached to the sclerotic coat, and must form, from its thickness, a complete support to the iris.

2. That as the incision is made throughout nearly perpendicular to the lamellæ of the cornea, the length of the incision of the internal lamella will be nearly equal to that of the external one, and will be greater than when it is made in the usual manner, by the semicircular incision; and consequently the cataract will be more easily extracted through it.

3. The upper edge of the internal incision is at a greater distance from, or further below the edges of the pupil.

4. As the flap of the cornea is very small, the external edge thick, and not easily moveable, or apt to be caught by the motion of the eyelids, the edges of the incision are not liable to be displaced, and consequently the wound has a much better chance of uniting by adhesion.

Lastly, the cicatrix which remains is scarcely perceptible, and cannot even be distinguished when the cornea is looked upon in a direction perpendicular to its surface. The incision should be made so that the inferior edge of the wound (fig. 3. *c*) is half way between the circumference of the cornea and the edge of the pupil, supposing the pupil to be in a moderate state of dilatation. If it be made nearer to the sclerotic coat, then the advantages to be expected from this mode of operating will be lost; and on the other hand, if it be made at too great a distance from the sclerotic coat, and consequently too near the pupil, the edge of the pupil will be apt to pass through between the lips of the wound. In one case in which this accident happened, partly on account of the incision being at too great a distance from the sclerotic coat, and also from the knife having been entered too far above the transverse diameter of the cornea, the wound was long in uniting, and after it was healed, the pupil remained very irregular and contracted.

In making the incision of the cornea in the manner that has been directed, another circumstance also particularly deserves notice, which is, that after having punctured both sides of the cornea, in giving the knife the motion round its axis, some of the aqueous humour escapes, and there is a great risk of a fold of the iris turning over the cutting edge of the knife. An operator who meets with this for the first time, is apt to think a wound of the iris is inevitable; but if he cautiously stops the progress of the knife by gliding the point of the fore-finger over the cornea, and pressing the iris from its edge, the incision may be completed with perfect safety.

It sometimes happens that after the knife has entered the cornea, the eyeball makes a sudden motion inwards, towards the nose, and a considerable part of the cornea is thus thrown out of view. This accident happens either from a fault in the operator or his assistant, and ought to be particularly guarded against; for when it has taken place, it is irremediable. When this happens, the operator must not attempt to proceed any further, but immediately withdraw the knife, allow the wound of the cornea to heal, the aqueous humour to be regenerated, and after any slight inflammation which might succeed, has gone off, the operation may be a second time attempted without any additional risk.

It sometimes happens that, on puncturing the cornea on the nasal side, the point of the knife does not come through at the proper distance from the sclerotic coat. If it pass through too near the centre of the cornea, as is represented in Plate DXVII. fig. 17. considerable disadvantage arises; for besides the incision being too small, so that the lens is extracted with difficulty, the eye is apt to receive considerable injury, and the cicatrix afterwards to interfere with vision. When this accident happens, it will be the most prudent practice to proceed no further in the operation, but to allow the wound to heal by adhesion, so that a second operation might be afterwards attempted with all the advantages of a first attempt. It is astonishing the rapidity with which a wound of the cornea made by a cutting instrument heals, and except it be very large, scarcely can the most acute eye detect any cicatrix. It is therefore much more prudent, whenever any fault in the incision arises, that the wound be allowed to reunite, so that afterwards a second operation may be successfully performed, instead of attempting by scissars or other instruments to correct any bungling. If the knife passes through the cornea too close to the sclerotic coat, it is not attended with such bad effects as when it passes too far from it; and was it not for the danger of wounding the iris, it would be advisable in all cases to lay it down as a general rule to make the knife come out very close to the sclerotic coat. See fig. 18.

Of the Mode of opening the Capsule of the Lens.

After the operator has completed the incision of the cornea, he should make a pause, and allow the patient to compose himself a little, in case of any involuntary motion of the eyeball injuring any part of its structure. It sometimes happens, indeed, that the moment the incision of the cornea is finished, the lens suddenly follows the

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the knife; but this is a circumstance never to be wished for, as the same cause which throws out the lens may also push after it some of the vitreous humour. When the incision of the cornea is finished, and nothing has escaped but the aqueous humour, the patient should be directed to turn his eye from the light, and to keep his eyelids shut, taking great care not to squeeze them, so that the pupil may be allowed to dilate. In most surgical operations, particularly those attended with much pain, it is of importance to finish them as quickly as possible. This, however, is not the case in the extraction of the cataract. It will be in general found that the severity of an injury done to any part of the body depends, not only on its extent, but on the sudden manner in which it is inflicted. Thus, a small drop of blood suddenly effused on the surface of the brain, often produces a series of much more distressing symptoms than a large collection of purulent matter in that organ. It is therefore reasonable to expect that if the different steps of the operation for the extraction of the cataract are gone through in a rapid manner, the eye will be much more injured than if the same operation be performed more slowly. There is another advantage too, derived from performing the operation in a cautious manner; by holding the eye firmly for some time, the muscles become fatigued, and during the latter steps of the operation, when there is the greatest danger of injuring the organ, the power of resistance to the operator is much diminished.

Mode of puncturing the capsule.

The next step of the operation is to make a puncture in the capsule of the crystalline lens, so that the lens may be brought through the pupil. On opening the eyelids, it will generally be found that the pupil has a very irregular appearance, which an inexperienced observer may suppose to be in consequence of a wound of the iris, though no such accident has happened. Some surgeons employ an assistant to support the upper eyelid, whilst others take both eyelids completely under their own management; and when the operator finds that he can easily accomplish this last mode, he should always prefer doing so. When the eyelids are opened in such a manner as to expose the incision of the cornea and pupil, the point of the instrument called the *curette* *, is to be introduced through the wound of the cornea and pupil, to puncture the capsule of the lens. Richter advises that the capsule should be punctured several times with the point of this instrument, in order that a large opening may be made into it. When the lens is soft and milky, this may be necessary, but when it is of a firmer texture, if one puncture be made, it sufficiently tears the capsule so as to allow itself to come away easily. Before introducing the *curette*, moderate pressure should be made on the eyeball, which has the effect not only of keeping the eye steady, but also of dilating the pupil. The convex part of the instrument (*a*) is then to be introduced through the wound of the cornea, and conducted to the central part of the pupil. When it reaches the pupil, from the curvature of the instrument, a very small turn of the handle will place the point upon the capsule of the crystalline lens, and by pushing the point upwards, the capsule will be readily punctured. It is not necessary that the point of this instrument be very thin and delicate; a rounded point will answer all the purposes of puncturing the capsule; whilst from this form there will be less danger of wounding the iris from any unexpected motion of the eyeball. Very little force is necessary to puncture the capsule, and when the point of the curette passes through it, it gives the sensation as if puncturing a piece of very fine paper with a pin.

* See Pl. DXVII. fig. 19.

This part of the operation we have often found to be one of the most difficult; for in many patients the eye becomes extremely unsteady, and whenever an attempt is made to hold it firm, or introduce the point of the curette, the eyeball is immediately rolled upwards under the roof of the orbit. The eyeball, too, is apt to make some untoward motion, after the point of the curette has been introduced into the anterior chamber; so that if the operator be not on his guard, the iris may be caught and torn by the point of the curette. In one case where, after the point of the curette was introduced through the pupil, the eye turned suddenly upwards, and the hooked part of the instrument catching the edge of the iris, pulled it downwards, though fortunately without tearing it.

Mode of Extracting the Lens.

Whenever the capsule of the lens is punctured, the lens in many cases begins to move forward, and the pupil to dilate. The operator, carefully watching this change, should keep up an equal and moderate pressure upon the eyeball, which will assist the lens in getting through the pupil. Whilst the lens is making its escape, and appears to press very much on the inferior part of the pupil, the iris should be supported by the back of the spoon, (*b* Plate DXVII. fig. 19.) which is generally, for conveniency, fixed upon the opposite end of the handle of the curette. In applying the pressure on the eyeball, it is of great importance that it be kept up uniformly, and it should always be proportioned to the effects which it appears to produce on the dilatation of the pupil. In most cases a very moderate pressure will be found to answer the purpose. We have met with other instances, however, where it was necessary to compress the eye with a good deal of force, before it was possible to remove the lens.

Any small portion of opaque lens which now remains in the capsule, or on its surface, must be extracted by means of a small scoop. When the fragment lies on the surface of the capsule, or in any part of the anterior chamber, it is in general easily removed; but when the opaque body remains within the capsule, it becomes necessary, that the scoop should enter the capsule through the opening which was made in it. When this opening is large and wide, the scoop will easily get in, and reach the opaque fragment; but, on the contrary, when the opening is small, the scoop may be moved about in every direction, in hopes of laying hold of it, for the scoop is on the outside of the capsule, and cannot procure an entrance. It has happened accordingly, that every endeavour to extract the remaining fragment has been fruitless, and in such cases it was supposed by the operator to adhere to the capsule. It was more probable, however, that the capsule had not been sufficiently opened, and that the scoop could not reach the small fragments. In all cases, however, it is an object of importance, completely to remove the opaque body; for though any remaining portions be ultimately absorbed, yet in the mean time the operation is by no means so complete as it would have been, had nothing been allowed to remain. It has been advised by some, (and the practice has certainly been attended with

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with good effects), that after the principal part of the lens is removed, any fragments which may remain, and which are not visible, may be brought into view by shutting, and cautiously rubbing the eye-lids with the finger.

Of the Extraction of the Capsule.

When, after the crystalline lens is removed, the capsule is found to be opaque, it is absolutely necessary that it be at the same time taken away. Opacities of the capsule are generally situated in its anterior parts, which renders the removal of them much more practicable. The forceps for this purpose (Plate DXVII. fig. 9.) are to be cautiously introduced through the wound of the cornea and pupil, and any opaque portion laid hold of, and cautiously removed. It has been observed that though the capsule did not appear opaque during the operation, yet in consequence of inflammation, which occurs more or less afterwards, the capsule has become opaque. This circumstance has led to a proposal, that in all cases the capsule should be extracted along with the opaque lens. From the natural structure of the eye, and the strong adhesion which exists between the posterior part of the capsule of the lens and the interior portion of the capsule of the vitreous humour, it would appear impracticable to separate them from each other, so as to extract the capsule entire. Many cases, however, are recorded by different authors, where, in performing the common operation, the lens inclosed in its capsule has made its escape. In these cases, however, it is probable, that the natural adhesion between the capsules of the two humours had been destroyed by some morbid alteration of structure. Such cases have probably been the cause of the proposal to extract in all cases the capsule of the lens. Mr Beer, a celebrated oculist in Vienna, has published a work *, in order to recommend and describe the mode in which such an operation should be performed. After some general observations on the bad consequences which arise from portions of the capsule remaining behind after the lens is removed, he describes his mode of operating in the following words.

* *Practische Beobachtungen.*

" Immediately after dividing the cornea, I dilate the pupil as much as possible, by a gentle pressure on the eyeball with the finger. I then introduce the lancet (Plate DXVII. fig. 4.) through the wound of the cornea, and plunge it into the lens; one surface being turned upwards, and the other downwards, so that none of the lancet is visible. It is particularly to be recommended to the instrument-maker, that this lancet have a pretty thick body, by which means, the moment of introducing it, the lens will be somewhat pressed back, and its weak anterior adhesion will be separated. The lancet must now, when in the middle of the lens, be moved upwards and downwards, in order to divide its connections above and below. Lastly, the instrument must be turned suddenly on its axis, and moved to the inner angle of the eye, and then drawn out in a straight direction. The lens often follows with its capsule, immediately after the lancet is withdrawn, or at least it comes out quite easily, along with its capsules, on a continued pressure of the finger. There is not merely a sleight of hand, which must be carefully observed in the use of the lancet; experience has taught me many precautions which must not be neglected the moment that the lens comes out, otherwise the capsule may be very easily rubbed off from the lens, either in passing the pupil, or in the wound of the cornea.

" In order to avoid this, the opening of the cornea should be made as large as possible, and it is best to divide two-thirds of it; thereby the operator has the following advantages.

" 1. The pupil dilates of itself after the division of the cornea by the pressing forward of the lens; and this dilatation may be easily increased by the slightest pressure.

" 2. The more the pupil is dilated, the better the operator can observe the management of the lancet; he can move his instrument more freely in different directions in the lens, and consequently separate more quickly and more surely, the lens along with the capsule, from all its connections.

" 3. The lens with its capsule passes more easily through the pupil, the wider the opening in the cornea, (which indeed requires in most cases much space), and the further and more easily the pupil dilates, the less danger there is of the capsule being separated on coming out. If the wound of the cornea is small, the capsule will be either separated from the lens in the pupil, or in the wound of the cornea, or passed back again either entirely, or at least partly, into the posterior chamber of the eye."

To those who are accustomed to perform operations on the eye, the method which we have detailed will at once appear to be difficult, extremely dangerous, and in many cases totally impracticable. The causes of failure in the operation for cataract seldom arise from an opacity of the capsule of the lens, and when this does occur, it is always in consequence of a violent or long-continued inflammation of the eyeball. Whenever, therefore, the inflammation which takes place after the operation is checked by proper remedies, a cataract of the capsule will seldom be met with.

Of the Treatment after the Operation.

After the lens has been extracted, and the eyelids allowed to remain shut for a short time, the eye ought to be examined, in order to ascertain that the edges of the wound of the cornea are in their proper place; that no portion of the iris has passed through it, and that the pupil is quite regular. When the incision of the cornea is made in the manner and of the size already described, the edges of the wound, from their firmness and thickness, accurately apply themselves to each other; and if the iris has sustained no injury, it will remain in its natural situation, and the pupil will become perfectly circular. When the pupil is not regular, it has been generally recommended to expose the eye to a bright light, in order to make it contract, and thus detach it from any part to which it might have adhered. When a portion of the iris protrudes through the wound, this generally arises, not from any injury in that part, but in consequence of the incision of the cornea having been made too large. If the incision be more than semicircular, (or two-thirds of the circumference of the cornea as directed by Mr Beer) this accident will almost constantly happen; and when it does take place, can never, as far as we know, be remedied. In such cases the operator should be careful not even to attempt with the spoon, nor any such instrument, to replace the prolapsed iris; for it has always been observed, that attempts of this kind are fruitless, and never fail to increase the inflammation which succeeds the operation.

In applying the necessary compresses and bandages on the eye, the objects to be held in view are, to keep the eyelids in such a position, that they cannot disturb the wound of the cornea by their motion, and that the eye be not exposed to any light. The upper eyelid will be completely secured, by placing over it, and in the hollow of the orbit, a small stripe of wet caddis. The piece of caddis should not be so large as to press much upon the eye, and from its being wet, it will be readily kept in its situation. Above the caddis should be placed a piece of linen covered with simple ointment, large enough to cover both eyes; and this may be secured by one turn of a bandage round the head. In applying the bandage, care should be taken to place it so that the pins are put in at the forehead and temples. The conveniency of this will be afterwards found, the bandage being easily removed without moving the patient's head from the pillow. The patient should now be put cautiously to bed, and his head kept extremely low. The room in which he sleeps should be made so dark, that no light may pass through the bandage to the eye. In an hour or half an hour after the operation, when the patient has become composed, he should be bled in the arm, if from the previous state of the patient's health that should be deemed a proper precaution. Rest, quietness, and abstinence, ought to be rigidly adhered to for the first day after the operation; the patient should be allowed none but liquid food, in order that any motions of the jaw may be avoided, and the food should be given through a tea-pot, in order to prevent any motion of the head. Sixteen or twenty hours are sufficient to produce an adhesion of the cornea in favourable cases; and after this period the compress of wet caddis placed upon the upper eyelid, becomes no longer necessary; for if it be allowed to remain any longer, it becomes hard and dry, and will be apt to irritate. The bandage and plaster ought therefore to be loosened, and the piece of caddis removed. The eyelids will now be found to adhere, and the patient will find much relief by cautiously wetting the ciliæ with cold water, in order to liberate the eyelids. From this period it is advisable to keep the eyelashes constantly greasy with an unctuous application.

In all cases, the symptoms which we are particularly to guard against after this operation, are those of inflammation: for when these arise, various effects may be produced which might frustrate all our endeavours to restore the patient's sight. If the wound in the cornea, instead of uniting by adhesion, goes through a tedious process of suppuration, the pupil becomes irregular and contracted; or if there is an effusion of lymph in the pupil, or if an opacity of the capsule takes place, these effects, all of which may arise in consequence of inflammation, might either greatly impair, or entirely destroy vision. The patient, therefore, ought to be carefully watched every six or eight hours for several days, and on the evening of the day of the operation, or at any future period, if symptoms arise which indicate the commencement of inflammation, he ought to be freely bled. The symptoms which are to guide us in adopting such means, are pain and uneasiness darting through the eye or head, and a frequent and full pulse. We have often remarked, after this operation, that even in those cases where no bleeding is necessary, the pulse becomes unusually full. This symptom alone would not, therefore, be sufficient to warrant us in proceeding far in adopting such a practice. We have long believed, that the success of all surgical operations, depends much on the adoption of the means to prevent any inflammatory action. The danger of amputation, and such operations in a vigorous and healthy constitution, is well known; it is equally well known the speedy recovery of patients from operations, who have been much debilitated from previous disease; and we have repeatedly remarked that patients who have lost much blood from some accident, after an operation, have recovered much more speedily than those to whom no such accident had happened. Aware of these circumstances, we have invariably adopted rigorously the depletive system after the operation for the cataract; and in many of those patients from whom a very considerable quantity of blood has at different periods been taken, we have observed that the success of the operation has been more speedy and more complete. The surgeon will sometimes find cases where, from the mildness of the symptoms, he is led to hesitate on the propriety of bleeding. In such a situation it is the safest plan to have recourse to it; for in general, wherever no symptoms have arisen which may indicate the impropriety of such a practice, if it be not useful, it is at least never followed by any bad consequences.

Venesection at the arm is the easiest and best mode of extracting the blood; but should any circumstances occur which render the operation at this place impracticable, or should it be thought necessary to take away the blood nearer to the inflamed organ, an opening may be made in the temporal artery. For the first two or three nights after the operation, the patient's arms should be watched, or secured in such a manner, that when he is asleep, he shall not be able to raise his hand towards his eye; for the most gentle stroke upon the eye, even several days after this operation, is attended with most excruciating pain, and is generally succeeded by violent inflammation. The patient should be enjoined to lie on his back, or on the sound side of the head; and after the first twelve hours he may be allowed to raise his head to the usual height. Most authors who have laid down rules to be followed after this operation, have directed that the eye should be kept shut up, and in total darkness for many days after the operation. We have, however, found an opposite practice attended with the most beneficial effects, and we have always considered it as a general principle to be followed, that the eye, from the very day after the operation, be gradually restored to its natural state, that the globe of the eye and eyelids be allowed to move, and that day after day the quantity of light to which it is exposed be gradually increased. In regulating the quantity of light, and the motion of the eye and eyelids, we should be entirely guided by the patient's feelings. Whatever be the quantity of light to which the eye is exposed, or its extent of motion, if it does not create uneasiness or pain, it will never be found to prove injurious; but on the contrary, if such a quantity of light be admitted as to create uneasiness, or if any motion of the eyes or eyelids gives pain, these circumstances will all tend to increase the inflammatory symptoms.

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It has been already mentioned, that on the first day after the operation, the wet caddis should be removed, and the eyelids separated and covered with some unctuous substance, so that the patient may, from time to time, cautiously move the eyelids, provided it gives him no uneasiness. The pledget of ointment covering the eyes will prevent, during this day, any light from entering.

On the second day the pledget of ointment may be removed, and both eyes covered with two or three folds of old linen, the patient being directed to bathe his eye frequently with a little warm water, so as to remove any glutinous or concreted matter from the eyelids. He should also continue frequently to move the eyelids, and by opening them, to expose the eye to the small quantity of light which passes through the linen. On the following days, the light is to be admitted more and more freely into the room, and by degrees the patient will find that he is able to look down upon the bedclothes, or any large object without uneasiness. People are often apt, from the joy which they feel in having their sight restored, to make too much use of the eye, and to render it weak and painful. Too much care, however, cannot be taken, to avoid any accident of this kind; and though the patient may feel his eye perfectly easy, and has no other complaint, yet it is always prudent to confine him to his bed for the first six or eight days. After the second or third day he may raise the head or body safely in bed; but we have repeatedly observed that when patients began to sit up early, and particularly when they approached too near a fire, they have been seized with a peculiar headach and inflammation of the eye, which were attended with much distress, and very difficult to remove. In ten or twelve days after the operation, the patient is commonly able to use the eye with considerable freedom, and to look even at minute objects without pain or uneasiness. It sometimes happens that after this period, a slight irritability of the eye remains, but this in general is speedily removed by the use of the vinous tincture of opium, or sometimes by the application of a weak ointment composed of the red oxide of mercury. The application of the vinous tincture of opium will be found peculiarly useful; and we have known many instances of patients who have undergone this operation, who were frequently, for a long time afterwards, attacked with slight pain or inflammation of the eye, which were always speedily and completely removed by the use of this medicine. It is scarcely necessary to observe that during the whole of the after treatment, the antiphlogistic regimen should be rigidly pursued, and that the patient should avoid every kind of food which from experience he knows to be apt to disagree with him; and that above all he should abstain from the use of wine and spirituous liquors of every description.

Of Couching.

By this operation the lens is depressed from its natural situation behind the pupil, by introducing a needle into the posterior chamber.

The operation may be performed by introducing a needle (Plate DXVII. fig. 20.) through the sclerotic coat, about two lines distant from its junction with the cornea. The point of the needle is to be directed immediately over the opaque lens, and the lens to be depressed a little with the convex surface of the end of the needle. The point is to be pushed in a transverse direction as far as the inner edge of the lens. Then the operator is to incline the handle of the instrument towards himself, by which means its point will be directed through the capsule into the substance of the opaque lens, and by inclining the needle downward and backward, the former will be lacerated and conveyed with the latter deeply into the vitreous humour. The treatment to be employed after couching is similar to that after extraction.

Sect. XI. *Of the Fistula Lacrymalis.*

When the lacrymal sac is distended with a puriform fluid, or when it has ulcerated, and the tears do not pass freely down the nasal duct, the disease is called *fistula lacrymalis*. In the first stage of the disease, a distinct tumor is formed in the situation of the sac, out of which, when compressed, a quantity of puriform fluid flows upon the eyeball through the puncture, or some of it passes through the nose. In the second stage of the disease, the integuments covering the sac ulcerate, and the puriform fluid and tears are constantly oozing through a fistulous opening. The eyelids are affected most commonly in the second stage of the disease, and sometimes also in the first, though not always. From the affection of the internal palpebral membrane, Scarpa has supposed that all the puriform fluid contained in the sac was secreted by it, but this does not always happen.

Treatment.—When the disease has originated in the mucous membrane of the eyelids, applications to it alone will be sufficient to remove the accumulation in the sac. A collyrium of the oxymuriate of mercury, and the daily application of the ointment of Janin, or of an ointment composed of the red oxide of mercury, are well suited for this purpose. When the sac has been the original seat of the disease, a solution of corrosive sublimate, acetite of zinc or of lead, will be useful, and these may be used by allowing them to be absorbed by the puncta into the sac, along with the tears, or by injecting them into the puncta by a proper syringe, (see Plate DXVII. fig. 23.).

If there be a complete obstruction in the nasal duct, these remedies generally fail, and it becomes necessary to open the sac, and remove the cause of obstruction in the duct. The sac may be readily opened by plunging a common lancet into it while distended with matter. The sac should then be examined with a probe, and the probe passed down into the nose in the direction of the natural canal. A surgeon well acquainted with the situation and direction of the duct, can never fail in introducing the probe; for we never met with any case where the obstruction could not be overcome. A style, (Plate DXVII. fig. 24.) such as has been recommended by Mr Ware, is to be introduced in place of the probe, and allowed to remain until the canal is quite open. When the parts around the sac appear healthy, the style may be withdrawn, and the opening of the sac then heals. In many cases the disease returns, and in such, after the parts are a second time healthy, a tube (Plate DXVII. fig. 25.) may be introduced and allowed to remain during life. This operation requires that there be a free external opening, and that the head of the tube be pressed completely

down

down below the edge of the skin. Generally the external opening heals in a few days. When the sac has ulcerated, there will generally be found some sinuses in the integuments covering the sac, all which should be freely laid open, and the style introduced as in the former case. After the skin and sac are apparently healthy, the tube may be introduced as in the former case. Besides the use of the style, it is also requisite to apply the eye-waters and ointments recommended in the first stages of the disease.

Sect. XII. *Of the Psorophthalmia.*

In this disease there are numerous small brown coloured eminences formed at the roots of the ciliæ of both eyelids, and generally both eyes are affected. The adjacent skin has a brownish red tinge, and becomes scurfy; the ciliæ drop out, and the patient has a difficulty and uneasiness in opening the eyelids, particularly in candle-light. The blood-vessels of the internal palpebral membrane are also turgid, and preternaturally numerous. This disease affects often many branches of the same family.

Treatment.—The unguentum citrinum is a specific remedy in this disease. When there is much inflammation of the eyelids, they ought to be scarified, and the ointment applied immediately after. A collyrium composed of a weak solution of corrosive sublimate is also sometimes useful.

Of the Ophthalmia Tarsi.

In many people who use their eyes much, particularly in candle light, and in those who live freely, the internal membrane of the eyelid often becomes gorged with blood; a thick puriform fluid glues the ciliæ together in the morning, and the patient complains of an inability to move the eyelids, or to look at an object in a bright or dazzling light, without much uneasiness being excited. In other instances the eyelids become affected with scrofulous inflammation, the glands of Meibomius swell and suppurate, the ciliæ drop out, and the eyelids lose their natural form.

Treatment.—Scarifying the inflamed vessels, and applying immediately afterwards a quantity of the red precipitate ointment, seldom fails in bringing relief, and in many instances the ointment alone will answer. In some cases the disease in the eyelid is much aggravated by, and connected with affections of the stomach and bowels, and in such the greatest attention becomes requisite to keep the belly regular, and even to purge.

Of the Entropion.

When the eyelids are inverted, so that the tarsus with its ciliæ come in contact with the eyeball, the disease is called *entropion*. This disease, Mr Crampton has shown, arises in some cases from a thickened and diseased state of the internal palpebral membrane. In others the ciliæ are turned in upon the eye from repeated and tedious inflammation altering the form of the tarsus, and in some old people where the integuments are very loose, the whole tarsus is inverted by the action of the orbicularis muscle.

Treatment.—In the first case, Mr Crampton has ingeniously recommended that the tarsi be divided at their junction towards the external canthus, and that the eyelids thus liberated be kept in their proper situation by plasters, compresses, and when in the upper eyelid by fixing the speculum of Pellier, until such time as the wound has healed. In the second case little can be done but pulling out from their roots any of the ciliæ which may have taken a wrong direction, and repeating the operation whenever they grow again. In the third case, the disease may be cured by removing an oval portion of the skin the whole length, and close to the tarsus, and uniting the wound by one or two stitches and adhesive plasters. This operation may be also advisable along with that of Mr Crampton, when one is not sufficient to cure the complaint.

Chap. XI.

Of the Diseases of the Ear.

The functions and structure of the internal membrane of the external meatus, and also of the eustachian tube and cavity of the tympanum, prove that it belongs to the mucous system, and that it is not a continuation of the periosteum as many anatomists have supposed. The analogy in the diseases of this organ prove the same. In catarrhal affections of the pituitary membrane of the pharynx, the ear is always more or less affected, and often the function of the organ is much impaired. Polypi also grow from the cavity and membrane of the tympanum of a similar structure to those found in other mucous surfaces. See *Polypi*. It is also subject to hæmorrhagies, and when it becomes inflamed, instead of suppuration taking place, there is a discharge of a puriform fluid from the surface, the same as what is observed in inflammation of the urethra, nose, &c.*

The internal membrane of the ear is also subject to the same kind of thickening and contraction of the canal, as takes place in the urethra and lacrymal sac, &c. in consequence of long continued inflammation †. This we might conclude from analogy, but the fact has been proved in one instance. Bichât dissected the body of a person who had been exposed during his life to a puriform discharge from the ear, in which he found a very remarkable thickening of the membrane of the tympanum, but no mark of erosion could be detected.

* See *Inflammation of the Mucous Membranes.*

† See *Strictures of Mucous Membranes.*

The most common disease of the ear, and almost the only one which the surgeon can relieve, is a collection of wax in the meatus externus. Its presence can always be determined by the inspection of the ear; and it can be removed by directing the patient to drop some warm water into the ear for a few successive nights, and afterwards syringing out the softened wax, an operation which may be performed with a syringe (such as is represented in Plate DXVII.), having fitted for it a pipe of considerable length.

Chap. XII.

Of the Diseases of the Nervous System.

Sect. I. *General Remarks on the Pathology of the Nerves.*

A great number of diseases have been considered under the class of *nervous;* and much obscurity has been thrown on this department of medical science, from

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from our imperfect knowledge of the laws which regulate this part of the natural system, and from mere symptoms having often been considered as primary affections.

Pathological investigations have been also unsuccessful; and in only a few cases has the most skilful anatomist been able to detect any morbid alteration of structure in nerves, which, during life, had been the seat of agonizing disease. In a few cases, where tumors have been found growing in their substance, it is not unlikely, that the cellular structure, connecting their fibrillæ, has been the part first affected. Their arteries and veins are subject to the diseases of these vessels in other organs; we have seen an aneurismal tumor as big as a hazel nut formed in the nutrient artery of the popliteal nerve; and Bichât mentions having seen the veins of the sciatic nerve varicose in a paralytic limb. Sir E. Home has described in the Philosophical Transactions a particular tumor of one of the axillary nerves, in which it is difficult to ascertain if the medullary portion be affected; and in the *Encyclopedie Methodique* there is a description of a case of disease, resembling, in some respects, that mentioned. The disease was in the middle of the radial nerve; and as the hand had neither lost its sensibility nor the movement of any of the fingers, this circumstance led to the supposition, that the *medullary* portion of the nerve was not affected, but merely its *neurilema*. In the *fungus hæmatodes*, it is by no means improbable that there is a morbid alteration in the medullary matter of the nerves; though this fact can only be determined by an accurate examination of the disease in various organs.

Most diseases belonging to this system have been fully treated of in the article MEDICINE. There is only one which becomes an object of surgical treatment.

SECT. II. *Of the Tic Doleureux* (Nevralgie).

Affections of this kind are distinguished by the nature of the pain, which is sharp, gnawing, and, particularly at its commencement, accompanied with torpor, and sometimes with pulsations. It is attended with no heat or redness, or any tension or swelling of the part. It comes on in paroxysms, more or less long, and at different intervals. Sometimes the attack is periodical.

The pain is always fixed in the trunk or branch of a nerve; and, during the paroxysm, it darts from the part first affected through all the ramifications of the nerve.

Many nerves of the body have been found affected with this disease. The first pair of the loins (nevralgie ilio-scrotale), the posterior crural (ischias nervosa postica), the crural, but particularly the nerves of the face are subject to it. When the disease affects the face, it is generally situated either in the frontal nerve, in the infra-orbitar nerve, or in the submental nerve. Sometimes the pain affects not only all the branches of these nerves, but it extends to their anastomosing branches, and spreads to one or more of the trunks.

This disease appears to be produced from a variety of causes, according to which its symptoms are varied. Sometimes it has been known to succeed a local irritation, such as an injury on the trunk of the nerve; and in other cases, the affection of the particular nerve is sympathetic of a disease in some distant organ.

Of Herniæ.

In some instances we have observed this disease arise from an affection of the primæ viæ; so that in all cases it becomes the first object of the surgeon to trace the cause of the disease.

Treatment.—When the stomach or intestinal canal are disordered, along with the particular affection of the nerve, the nervous affection will often cease when they are restored to their natural state. This is to be accomplished in most cases by emetics, and a course of laxative medicines, pursued according to the qualities and quantity of the evacuated matter.

In some cases, particularly in the affection of the frontal nerve, we have found great relief from the repeated application of small blisters over the nervous trunk. In some instances, too, the patients have experienced great relief, and have even completely recovered, by a continued attention to a very spare vegetable diet, or to a milk diet. The celebrated Marmontel was a remarkable instance of this kind.

There are, however, cases where these means fail, and where the disease appears to depend on some fixed cause of irritation in the affected nervous trunk. In such cases, it is the usual practice to divide the trunk of the nerve. This operation generally gives instant relief; but its effects have, we believe, in most cases, been but of short duration. It is a fact completely established, that the ramifications of the nervous as well as of the vascular system, though divided, are gradually regenerated. The numerous anastomoses preserve the life of the part on which the divided trunk was distributed, and the divided edges of the trunk gradually coalesce; so that the nerve is again able to perform its natural functions. This reunion of the nerves does not take place so rapidly as we observe it in the arteries, in the skin, cellular membrane, or muscle; and months elapse before it is completed: but, from this reunion, it is probable, that the morbid action in tic doleureux, of the nature of which we are ignorant, the operation, in most cases at least, brings merely temporary relief.

When the operation is to be performed, the necessary steps are extremely simple. Some have contented themselves with introducing a sharp-pointed bistoury through the integuments towards one side of the exit of the nerve, passing the point underneath it, and then dividing it; thus leaving only a small puncture of the skin.

When, however, the operation is done in this manner, the divided extremities, from being separated only a little way, are apt immediately to reunite; a circumstance which should be prevented. We could therefore advise that a free incision be made immediately above the nerve; that the nerve be completely divided, and either a portion cut altogether away, or the divided extremities separated to a distance, and the wound allowed to heal by suppuration.

CHAP. XIII.

Of HERNIÆ.

THE word hernia has been used to signify a protrusion of any viscus, from its proper cavity; but we shall only treat in this place of abdominal hernia. The viscera of this cavity are most frequently protruded at the inguinal and

Of Herniæ. and crural rings and the umbilicus. They, however protrude also at the *foramen ovale*, at the *perinæum*, through the *ischiatic notch*, and *diaphragm*.

The names that have been given to different kinds of hernia, have been derived both from the contents of the hernia, and from its situation. If they contain omentum only, they are called *omental hernia*, or *epiplocele*; if only intestine, *intestinal* hernia; if both, omentum and intestine, *entero-epiplocele*; if the stomach is contained in the tumor, *gastrocele*; if the liver, *hepatocele*; if the bladder, *cystocele*; if the uterus, *hysterocele*.

The peritonæum generally protrudes prior to any of the viscera, forming a bag called the *hernial sac*, in which the protruded viscera are afterwards contained. The protruded portion of peritonæum is not dragged from its natural situation, but becomes elongated by gradual distension; and it is usually not only lengthened, but more or less thickened.

Sect. I. *Of the Inguinal Hernia.*

In an inguinal hernia, the protruded viscus enters the *abdominal* ring, passes along the inguinal canal, and comes out either at the inguinal ring, and goes into the scrotum (scrotal hernia), or bursts through the tendon of the external oblique muscle (inguino-abdominal). Or, it passes through the tendon of the transversalis, and internal oblique, and appears at the inguinal ring (abdomino-inguinal).

Inguinal hernia is more frequent in men than women, the round ligament of the uterus being of a smaller size than the spermatic chord. It sometimes appears on both sides, but most frequently on the right side.

Appearances on dissection. When the skin of the scrotum of an inguinal hernia is removed by dissection, a fascia is found lying underneath it, which varies in thickness according to the bulk and duration of the tumor. This fascia comes off from the tendon of the external oblique muscle above the abdominal ring. Below this fascia is the cremaster muscle, which is united both to the fascia and hernial sac, though easily separable from them by dissection. When the fascia and cremaster muscle are removed, the hernial sac is exposed. The epigastric artery is situated on the *pubic* side of the sac. The spermatic cord lies generally behind the sac; sometimes to one side, and sometimes on its anterior part. Often the vessels of the cord are split, the epididimis passing along one side of the sac, and the artery, veins, and absorbents, on the other. Sometimes there are more than one hernial sac on the same side. Mr Cooper found, in one case, two within the inguinal canal. This arises in some cases from wearing a truss.

In the *inguino-abdominal herniæ*, the sac enters the abdominal ring; and, instead of being continued along the inguinal canal, it passes through the tendon of the external oblique muscle. The hernial sac, in this case, is composed of two distinct layers; the one internal and peritoneal, the other external, and produced by an elongation and gradual thickening of the aponeurosis of the external oblique muscle *.

* Merry and Petit.

In the *abdomino-inguinal* hernia, the sac passes through the tendon of the transversalis or the tendons of both the transversalis and oblique muscle, enters the inguinal canal, appears at the inguinal ring, and then passes down into the scrotum. In this case, Mr Cooper observes, that the spermatic cord lies on the upper or outer part of the sac. The epigastric artery lies on the outside of the sac †.

† Richter, Dessault, Rougemont.

The inguinal hernia is generally pyriform, small towards the ring, and enlarging as it descends. It may be distinguished from other swellings of these parts, by the following symptoms: 1. When the patient is desired to cough, the tumor becomes immediately distended, owing to the pressure of the abdominal muscles forcing into the sac more of the viscera or of their contents. 2. When the patient can remember that the tumor used to disappear when in the horizontal position. 3. When the progress of the tumor has been from the groin to the scrotum. 4. When the tumor contains intestine, it is elastic and uniform; and, when pushed up into the abdomen, it returns with a gurgling noise. When omentum is contained, the tumor is less equal on its surface, receives an impression with the fingers, and does not return with a gurgling noise. Most commonly, however, both intestine and omentum are contained in the sac. 5. The functions of the viscera are somewhat interrupted, producing eructations, sickness, constipation, colicky pains, and distension of the abdomen.

The inguinal herniæ ought to be carefully distinguished from hydrocele of the vaginal coat, from encysted hydrocele of the spermatic cord, from enlargements of the testicle, from hæmatocele, and from varicocele. Hydrocele and hernia, too, are often combined, particularly omental herniæ.

Sect. II. *Of reducible Inguinal Hernia, and of Trusses.*

Herniæ are either reducible, irreducible, or strangulated. In the reducible state, the parts may be returned into the cavity pf the abdomen. To prevent the escape of the bowels, and the danger of such an accident, a constant pressure should be applied at the part where the hernia opens into the abdomen, to shut the mouth of the sac, and thus oppose an effectual resistance to the protrusion of its contents. To accomplish these purposes, various *trusses* have been contrived. The truss should be made of steel, and the spring not stronger than is sufficient to keep up the bowels; for, if the pressure be great, the abdominal muscles, where it is applied, are weakened, and even absorbed. Mr Cooper advises the pad to be made of a conical form, the apex of which should rest on the mouth of the sac. But, as there will be found much variety in the situation and size of the opening through which the hernia passes, it will often be necessary to vary the form and bulk of the pad. The truss ought to be applied so that it makes pressure not on the inguinal ring where the hernia comes out, but upon that part where the spermatic cord, and with it the hernia, first quit the abdomen; and this point may always be determined, by making the patient cough after the hernia has been reduced, and ascertaining the furthest part from the inguinal ring, where the hernial sac is found to protrude. On this point the pad should rest. If the pad be too large, and press merely on the inguinal ring, it will allow the bowels to pass through the internal or abdominal ring, and enter into the inguinal canal. On the other hand, the pad should not

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not be too small, so as to press into the mouth of the sac and plug it up, for that would prevent all chance of a permanent cure; the bowels may be prevented from entering into the sac; but the pad will act as a dilater or bougie, keep the mouth of the sac constantly open, and even increase its diameter. The pad, therefore, ought always to be made of such a size and shape, as to make a pressure on the abdominal ring, inguinal canal, and inguinal ring.

Sect. III. *Of Irreducible Herniæ.*

Herniæ become irreducible when the protruded parts are suffered to remain long in the hernial sac and increase much in bulk, when membranous bands form across the sac and entangle its contents, or when an adhesion takes place between the sac and its contents, or amongst the contents themselves.

Treatment.—In such cases, a bag truss ought to be worn, so as to keep up a uniform and steady pressure on the scrotum. The application of ice, too, has been known to procure the return of a hernia which appeared irreducible.

Sect. IV. *Of Strangulated Herniæ.*

A hernia is said to be strangulated when not only the intestine and omentum are irreducible, but when the protruded bowels are inflamed, and when the passage of the fæces through the strangulated portion is completely interrupted.

Symptoms. The tumor is attended with considerable pain, which sometimes extends through the abdomen, and is often situated at the umbilicus. Hiccup and vomiting succeed; at first the contents of the stomach only are evacuated, but afterwards those of the lower portions of the alimentary canal. The bowels are completely obstructed, except that portion below the seat of strangulation. The pulse is commonly quick and hard; sometimes, however, it is full. If the disease continues, the skin covering the tumor becomes discoloured and slightly œdematous, and the abdomen tender and tense; the pulse becomes small and thready, the countenance has an expression of anxiety; and all these symptoms are subject to exacerbations. They are greatly mitigated for a while, but soon recur with increased violence.

After having suffered great pain during the first stage of the disease, the patient becomes suddenly easy, and the tumor becomes of a purple colour, and has a crackling feel. The abdomen becomes more tense, a cold sweat covers the body, and the pulse is weak and intermittent. At last the patient, deluded with the hopes of a recovery, sinks under the complaint.

Appearances on dissection. On dissection, the hernial sac is generally found to contain a quantity of dark bloody serum. The intestine is of a dark chocolate brown, with black spots interspersed over it, which are easily torn on being touched with the finger. The surface is covered with a layer of coagulated lymph. Even when the intestine is not mortified the colour is extremely dark, but then the black spots do not appear. Within the abdomen the whole intestinal canal sometimes appears quite natural; at other times portions of the intestines appear inflamed, and in some rare cases they are glued together by an effusion of lymph.

On examining the seat of stricture, it will be found to take place either at the abdominal or inguinal ring. In large herniæ, Mr Cooper has remarked that the stricture is most frequent at the external opening, and then it may be often seen from the particular shape of the tumor, a constriction being distinguishable at that part. In other cases the stricture is seen at the entrance of the spermatic vessels into the inguinal canal; so that, in operating for hernia, it is not sufficient to dilate the external ring, but it becomes necessary to dilate the upper part of the canal.

Treatment.—In the treatment of strangulated hernia, the leading object which is to be kept in view, is to return the displaced viscera as speedily as possible, and, at the same time, while doing this, to diminish the symptoms of inflammation or prevent their accession.

Taxis. The first thing to be attempted, except when the tumor is much inflamed and painful, is the *reduction* of the hernia. In doing this, it is necessary to attend to the position of the patient and the mode of applying the pressure. The body of the patient should be placed on an inclined plane, with the head downwards, and the thighs bent towards the trunk of the body. The pressure which is employed on the tumor should always be directed upwards and outwards along the course of the spermatic cord, and it may be persevered in from a quarter to half an hour. Besides these mechanical means, tobacco clysters and cold have been useful in accomplishing the reduction. Ice is the easiest and best mode of applying cold to hernial tumors; but, when this cannot be procured, Mr Cooper uses a mixture of equal parts of sal ammoniac and nitre. To one pint of water in a bladder, ten ounces of the mixed salts are added, the bladder tied up, and then laid over the tumor. If, after four hours, the symptoms become mitigated, and the tumor lessens, this remedy may be persevered in for some time longer; but if they continue with equal violence, and the tumor resist every attempt to reduction, no further trial should be made of the application.

Operation. The operation which it is now necessary to perform, consists in making an incision through the integuments along the upper part of the tumor, making an opening into the hernial sac, and extending it, so as to allow the contents to be examined, and the fore finger to reach the seat of stricture. The stricture will be readily detected by the point of the finger, and may be easily divided by introducing the bistoury along the finger, till the point of it passes below the stricture *. A very slight pressure of the edge of the instrument will be sufficient to divide the stricture, and allow the bowels to be returned into the abdomen. If merely the stricture is divided, and it is never necessary to extend the incision further, it is of little importance in which direction the incision is made; though surgeons have been at great pains to point out the dangers which might arise were it of too great an extent.

* See Plate DXIX.

Sect. V. *Of Femoral Herniæ.*

In femoral hernia, the hernial sac lies beneath the crural arch, being pushed through an opening between the edge of the broad insertion of Poupart's ligament and the pubic side of the femoral vein †. As the tumor enlarges, instead of falling downwards like the inguinal hernia,

† See Plate DXX.

Of Femoral Herniæ.

hernia, it passes forwards, and often turns over the anterior edge of the crural arch. As it proceeds, the swelling increases more laterally than upwards or downwards; so that it assumes an oblong shape. In the crural hernia, the sac has two coverings besides the integuments; the superficial fascia of the external oblique muscle, and the *fascia propria* of Mr Cooper, which is formed by the protrusion of the fascia which naturally covers the opening through which the hernia passes, and the fascia of the crural sheath. The taxis and use of trusses are the same in femoral as in inguinal hernia; and the same series of symptoms indicate the necessity of an operation in both when strangulated.

Operation.—Mr Cooper recommends that the incision of the integuments be made in the form of a T, beginning one incision about an inch and a half above the crural arch, in a line with the middle of the tumor, and extending it downwards below the arch, and meeting a second incision nearly at right angles with the other, the whole length of the tumor. The two fascias are next to be divided, and the hernial sac opened at its lower part, sufficiently large to admit readily the finger. The seat of the stricture is to be ascertained by the introduction of the point of the fore finger under the crural arch, and it may be readily divided in a direction upwards and inwards, of a sufficient extent to liberate the intestine; generally a very slight motion of the edge of the bistoury will be found sufficient for that purpose.

Chap. XIV.

Of Hare-lip.

The hare-lip is a fissure in the upper lip, very seldom in the under one.* It is attended with want of substance, and has its name from a resemblance to the lip of a hare. In general it is only a simple fissure, though sometimes it is double.

*See Plate DXXIV.

In proceeding to the operation, the patient, if a child, should be secured upon a table; but if an adult, he is to be seated upon a chair, in a proper light. The frænum connecting the gums to the upper lip is to be divided; if a fore-tooth project so much as to prevent the parts from being brought properly together, it is to be extracted; or when the fissure runs through the bones of the palate, if a small portion of the bone project, this must be removed. The operator is then to lay hold of one side of the fissure between the thumb and fore-finger, or between the forceps †, then with a pair of sharp and very strong scissars, or with a scalpel, to cut off a thin portion of the lip, and to repeat the same thing upon the other side of the fissure, so as to render the whole edges of the fissure completely raw; by which, if the operation be properly performed, a piece will be separated in form like an inverted V. After the incisions have been made, the vessels should be allowed to bleed freely to prevent inflammation; and when the bleeding has ceased, the sides of the wound are to be brought accurately together, and kept in that state by the twisted suture. The first pin ought to be as near as possible to the red edge of the lip; another is to be inserted near the upper angle; and if the patient be an adult, a third pin will generally be necessary, half way between the other two. In passing them, they ought to go rather deeper than half through the lip, that the edges of the wound may be kept properly in contact. An assistant now keeps the parts together, while the operator applies a firm waxed ligature first to the under pin; and having made three or four turns with it in the form of an eight figure, it should then be carried about the second, and in a similar way about the third, care being taken that the thread be drawn of a proper tightness. When, from a great want of substance, the retraction has been considerable, some advantage is derived from the use of adhesive plasters applied to the cheeks and tied between the pins. During the time of the cure the patient should be fed upon spoon-meat, and prevented from making any exertion with the lips, otherwise the cure might be considerably retarded. At the end of five or six days the pins may be taken out, when the parts will commonly be found completely united.

† Plate DXXIV.

Amputation.

In the case of a double hare-lip, the operation should be first done upon one fissure; and when a cure is completed there, it may be done safely upon the other.

Chap. XV.

Of Amputation.

There are two modes generally employed for performing amputation; the common operation by two circular incisions, and the *flap* operation. We shall describe in detail both these modes of operating in the thigh.

Amputation of the thigh.

The patient should be placed on a table of a convenient height, in such a manner that the diseased limb may hang over the edge of it, and be secured by an assistant seated on a low chair before him; the other limb and the arms are also to be secured by proper assistants. The tourniquet (see Plate DXVI.) is to be placed on the thigh, three or four inches below Poupart's ligament, where the femoral artery may be most easily and completely compressed. Dessault preferred to the tourniquet, the finger of a strong and intelligent assistant. A cushion fixed on a handle answers very well for making pressure on the artery when a tourniquet is not to be used; and it is a useful instrument to have in readiness, in case the tourniquet should go wrong; or when it becomes necessary to amputate the thigh so far up, that a tourniquet cannot be safely fixed.

After the operator has determined on the place for the incision of the integuments, an assistant should grasp the limb with both hands a little above where the skin is to be divided, and draw it upwards as far as possible. The operator then with the knife (see Plate DXXII. fig. 10.) makes a circular incision through the skin and cellular membrane, down to the muscles; and this may be done, either by one stroke of the knife, or by first making one semicircular incision round the under part of the limb, and afterwards another incision upon the upper part corresponding with the former. When this is made, the integuments retract considerably from their natural elasticity, and they are to be separated from the muscles and dissected with the point of the knife, as far back as to leave a sufficient quantity of skin to cover the stump. The skin being turned back, the operator, Amputation. operator, by a second incision carried close to its inverted edge, cuts the muscles perpendicularly down to the bone. During this part of the operation, care should be taken to avoid wounding the edge of the skin, by tracing attentively the edge of the knife during the whole course of the incision. After the muscles are divided, a considerable retraction takes place, and any muscular fibres attached to the periosteum should be separated from it by the point of the knife, in order to allow the bone to be sawn through as high as possible, and thus secure to it a firm fleshy covering. All the soft parts are next to be drawn upwards as far as their separation from the bone will admit of. They are to be kept in this situation by an instrument called the *retractors*, until the bone is sawn through. The retractors may be either made of iron plates (see Plate DXXII. fig. 5.), or a piece of linen or leather cut as represented in fig. 6. The assistant who uses either of these instruments, should take care when he applies them, that the soft parts are completely out of the reach of the saw, and that they are held back as far as the place where the bone is to be divided. Any sharp edges which may be left on the end of the bone after it has been sawn through, should be taken away with pliers, Plate DXXII. fig. 8. The arteries are next to be tied, and both the femoral artery and vein may be included in one ligature. The bleeding being stopped, and the wound cleaned, the tourniquet is to be altogether taken away, and the soft parts drawn down, so as to cover the extremity of the bone. In order to keep them in this situation, a bandage of thin flannel or cotton cloth, not exceeding two inches and a half in breadth for an adult, is to make one or two circular turns round the body above the ilium; it is then to be carried obliquely over the groin, and turned round the upper part of the thigh pretty firmly two or three times, forming as it were at this place a point of support to the muscles and skin. It is afterwards to be passed in a spiral manner downwards to near the edge of the wound, taking care to pull the soft parts towards the stump, whilst applying each turn of the bandage. The turns should not be so tight as to cause pain, but sufficient to keep the parts in the situation in which they are placed. The surface of the muscles and the edges of the skin are now to be accurately brought together in such a direction, that the wound forms a straight line, extending from the anterior to the posterior aspect of the limb. Strips of adhesive plaster, about half an inch in breadth, and eight or ten inches in length, should be applied, in order to keep the lips of the wound in this position. Those over the middle part of the wound ought to be put on first; and great attention is necessary in their application, to prevent the edges of the skin from overlapping and puckering. They should be of such a number as completely to cover the surface of the wound, leaving only a small opening for the ligatures of the arteries to be brought out at that part of the wound nearest the place where the artery is situated. The wound is to be afterwards covered with a piece of linen or caddis spread with simple ointment, and a compress of fine tow laid over it, the whole being secured by a few turns of the roller.

The bedclothes should be kept from pressing upon, and coming in contact with the stump, by a frame or cradle, as it is called. (See Plate DXXIII. fig. 11.).

Lithotomy. Flap operation. When this operation is to be performed, the incision of the integuments may be made, either with a common scalpel, or with the end of the amputating knife, as represented in Plate DXXII. fig. 10. After the skin is divided, it is of importance to allow it to retract as much as possible, by cutting the fibres of cellular membrane which connect it with the fascia of the thigh, before dividing the muscles. If the limb be much emaciated, the division of the muscles may be also made with the scalpel; if, on the contrary, the limb be bulky, the incision ought to be made by a common amputating knife, in order that the surface of the flaps be plain and uniform. After dividing the muscles obliquely upwards down to the bone, they should be separated from it a sufficient way, so as to leave enough to cover the end of the bone, and they should be allowed to contract as much as possible before the bone is sawn through. After the limb is amputated, and the circular bandage applied, the flaps will be found to meet very accurately together, and to form a round and smooth stump. From the angles of the skin being removed, no puckering or corners are left, and the two surfaces and muscles being applied to each other, and covering the end of the bone, give it a firm and fleshy covering, whereas in amputations performed in the common mode, the bone is covered by integuments alone. The adhesive plasters are to be applied in the same manner, and the patient is to be treated afterwards as in the other modes of operating.

The general rules to be attended to in amputation in other parts of the body, are the same as those already mentioned; and in Plate DXXII. and DXXIII. we have delineated the place and direction of the incisions.

Chap. XVI.

Of Lithotomy.

The manner of preparing the patient for this operation depends upon a variety of circumstances. If he be plethoric, a few ounces of blood should be taken away. and at proper intervals the bowels ought to be emptied by any gentle laxative which will not gripe. The diet should consist of light food for some time previous to the operation. If the pain be violent, opium is necessary. Sometimes it is relieved by keeping the patient in bed with the pelvis raised, so as to remove the stone from the neck of the bladder. He ought not to sit up, or take any exercise, in the time of preparation. The warm bath ought to be used two or three times, and the patient should remain in it half an hour at each time. A laxative ought to be given on the day preceding the operation, and an injection a few hours before it is performed. The patient ought to drink plentifully of some diluent liquor, and to retain the urine several hours previous to the operation. If this cannot be readily effected, a slight compression, by means of a ligature, may be made upon the penis, so as to have the bladder sufficiently distended, that there may be no danger of the posterior surface being hurt by the end of the gorget. The perinæum and parts about the anus should be well shaved.

A table somewhat more than three feet in height, and of sufficient strength, is to be firmly placed, Lithotomy. and properly covered with blankets, pillows, &c. Upon this the patient is to be laid and properly secured; and for this purpose there ought to be two pieces of broad firm tape, each about five feet in length, which are to be doubled, and a noose formed upon them. A noose is to be put upon each wrist, and the patient desired to lay hold of the middle of his foot upon the outside. One end of the ligature is to go round the hand and foot, and the other round the ankle and hand, and cross again, so as to repeat the turns in the reverse way. A running knot is to be tied, by which the hand and foot will be properly secured. The buttocks are then to be made to project an inch or two over the table, and to be raised considerably higher than the shoulders by a couple or more pillows, and one pillow ought to be put under his head.

The operator is now to introduce a grooved staff (Plate DXXI. fig. 5.) of proportionable size, and open to the end, through the urethra into the bladder; and having fully satisfied himself of the existence of a stone, he inclines the staff, if he be right-handed, obliquely over the right groin, so that the convex part of the staff may be felt in the perinæum on the left side of the raphe. He then fixes it, and delivers it to his assistant, who is to hold it with his right hand, desiring him to press it gently, in order to make the sulcus of the staff project in the direction in which he received it. With his left hand the same assistant is to raise and support the scrotum.

The thighs of the patient being sufficiently separated by the assistants, and the surgeon being seated upon a chair of a proper height, and in a convenient light, he makes an incision with a common convex-edged scalpel through the skin and cellular substance, below the symphysis of the ossa pubis, which is a little below the scrotum, and where the crus penis and bulb of the urethra meet, and on the left side of the raphe, and continues it in a slanting direction downwards and outwards to the space between the anus and tuberosity of the ischium, ending somewhat lower than the basis of that process, by which a cut will be made of three or four inches in length. This incision ought not to be shorter than is here directed, otherwise there will not be room for the rest of the operation. As soon as the integuments are divided, he ought to introduce two of the fingers of the left hand. With one he keeps back the lip of the wound next the raphe, and with the other he presses down the rectum. He ought likewise particularly to guard against cutting the crura of the penis, which he can readily feel, and separate at their under part with one of his fingers. He next makes a second incision almost in the same direction with the first, but rather nearer to the raphe and anus, by which he preserves the trunk of the *arteria pudica*. By this incision he divides the transversalis penis, and as much of the levator ani and cellular substance within these as will make the prostate gland perceptible to the finger. If any considerable vessel be cut, it is immediately to be secured, though this is seldom necessary. He is now to search for the groove of the staff with the fore finger of his left hand, the point of which be presses along from the bulb of the urethra to the prostate gland which surrounds the neck of the bladder. He keeps it there; and turning the edge of the knife upwards, he cuts upon the groove of the staff, and freely divides the membranous part of the urethra, till the staff can be felt perfectly bare, and that there is room to admit the nail of the finger; and as the finger assists in keeping the parts stretched, and effectually prevents the rectum from being hurt, the incision into the urethra may be made with perfect ease and safety.

The next part of the operation, viz. dividing the prostate gland and neck of the bladder, might, by a dexterous operator, be safely performed with a common scalpel with the edge turned the opposite way. But to guard against accidents, a more convenient instrument, called the *cutting gorget*, is now in general use. It was originally invented by Mr Hawkins of London, and since his time has undergone various alterations *. The membranous part of the urethra being now divided, and the fore finger still retained in its place, the point of the gorget, previously fitted to the groove, is to be directed along the nail of the finger, which will serve to conduct it into the groove of the staff; and as this is one of the nicest parts of the operation, the most particular attention is required that the point of the gorget be distinctly felt to rub in the bare groove.

* See Plate DXXI. fig. 1.

The operator now rises from his seat, takes the staff from the assistant, raises it to near a right angle, and presses the concave part against the symphysis of the ossa pubis; satisfies himself again that the point or beak is in the groove, and then pushes on the gorget, following the direction of the groove till the beak slip from the point of the staff into the bladder. The gorget is not to be pushed farther than this, otherwise it may wound the opposite side of the bladder, &c.

The gorget having now entered the bladder, which is readily known by the discharge of urine from the wound, the staff is to be withdrawn, and the finger introduced along the gorget to search for the stone, which, when felt, will point out the direction to be given to the forceps; at any rate, the introduction of the finger serves to dilate the wound in the bladder; and this being done, a pair of forceps † of a proper size, and with their blades as nearly together as their form will allow, are to be introduced, and the gorget withdrawn slowly, and in the same direction in which it entered, so as to prevent it from injuring the parts in its return. After the forceps are introduced, and passed till they meet with a gentle resistance, but no farther, the handles ought to be depressed till they are somewhat in an horizontal direction, as this will most correspond with the fundus of the bladder. One blade of the forceps is to be turned towards the symphysis of the pubes, to defend the soft parts there; the other of consequence will guard the return. After they have distinctly touched the stone, by moving them a little in various directions, they are then to be opened, and the stone laid hold of, which may generally be done with considerable ease. It frequently happens, however, that when the stone is small, it is not readily felt with the forceps; and instances may happen where the under and back part of the bladder may be so depressed as to conceal the stone. In such a situation, nothing will more readily bring it in the way of the forceps than to introduce the finger into the rectum, and elevate this part of the bladder. Straight forceps are generally used; crooked ones, in some very rare cases, however, may be necessary, and therefore the surgeon ought to be provided with them.

† Plate DXXI. fig. 6. & 7.

After

Lithotomy. After the forceps has laid hold of the stone, if it be small and properly placed, it may readily be extracted: but if, on the contrary, the handles of the forceps are now observed to be greatly expanded, it is certain the stone is improperly fixed, or that it is remarkably large: in either case it should not be held fast, but allowed to move into the most favourable situation; or the finger is to be introduced so as to place it properly for extraction. If this cannot be done with the finger, it ought to be allowed to slip out of the forceps, in order to get it more properly fixed; and as the most common form of the stone is flat and oval, or somewhat like a flattened egg, the forceps should have hold of the smallest diameter, while an end presents to the neck of the instrument. The stone should be grasped with no greater firmness than is merely sufficient to bring it fairly out, and it should be extracted in a slow gradual manner.

EXPLANATION OF THE PLATES.

Plate DXIII.

Fig. 1. and 2. Common scalpels. Fig. 3. A blunt-edged silver knife for dissecting close to important parts. Fig. 4. and 5. A sharp and blunt-pointed bistoury. Fig. 6. Richter's hernia knife. Fig. 7. Dissecting forceps. Fig. 8. A blunt hook. Fig. 9. and 12. Directories. Fig. 10. and 11. Dissecting hooks. Fig. 13. Lancet. Fig. 14. 15. and 16. Seton-needles. Fig. 17. and 18. Sharp and blunt-pointed needles. Fig. 19. Outline of a steatomatous tumor, the dotted line pointing out the direction in which the incision of the integuments ought to be made for its extirpation.

Plate DXIV.

Fig. 1. 2. and 3. shew the different forms of the points of bougies. Fig. 4. 5. and 6. are different sizes of silver balls used by Mr C. Bell for introducing into the urethra, in order to determine the form and length of strictures. Fig. 7. an outline taken from a cast of the urethra, to shew the difference of the diameter at different parts of that canal. Fig. 8. and 9. shew the form of strictures in the urethra. Fig. 10. shews a stricture in the œsophagus. Fig. 12. and 13. Male and female syringes. Fig. 14. Scarificator for the throat. Fig. 15. is the apparatus for injecting hydrocele.

Plate DXV.

Fig. 1. and 2. Forceps for removing polypi described in Chap. III. Sect V. Fig. 3. 5. and 6. Instruments for removing polypi by ligature. Fig. 7. Outline of one large and two small polypi in the rectum. Fig. 8. A breast-glass. Fig. 9. Cheselden's needle. Fig. 10. A speculum oris. Fig. 11. Mudge's inhaler.

Plate DXVI.

Fig. 1. Drawing of a femoral aneurism given by Mr Freer. *a* is the direction and extent of the incision as made by Mr Abernethy. The artery, however, may be more easily tied by making an incision parallel to Poupart's ligament (*b*). *c* is the place and direction where the incision ought to be made in the high operation for popliteal aneurism. Fig. 2. is the instrument used for compressing the artery or aneurismal tumor. Fig. 3. The common tourniquet.

Plate DXVII.

Fig. 1. 2. and 3. Different forms of extracting knives. Fig. 4. Beer's lancet for extracting the capsule of the lens. Fig. 5. Instruments for scarifying the eyelids. Fig. 6. A thin scalpel for paring the cornea. Fig. 7. Instrument for holding down the under eyelid. Fig. 8. Pelier's speculum. Fig. 9. Capsule forceps of Wenzel. Fig. 10. Eye scissars. Fig. 11. 12. 13. 14. and 15. have been referred to in N° 224. Fig. 16. represents the wound of the cornea where the knife has been entered too near the inner edge of the pupil; Fig. 17. where it has been brought out at too great a distance from the sclerotic coat; Fig. 18. where it has been brought out too close to the sclerotic coat. Fig. 19. A curette and Daniel's spoon. Fig. 20. Scarpa's needle: Fig. 21. shews its point magnified. Fig. 22. Common spear-pointed couching needle. Fig. 23. Fistula lachrymalis syringe. Fig. 24. The style for introducing into the lachrymal duct. Fig. 25. Tube for introducing into the lachrymal duct; and fig. 26. Instrument for introducing the tube.

Plate DXVIII.

Shews the external appearance of hernia. Fig. 1. is a femoral hernia, the tumor being unequal and divided into two portions at *a;* the iliac portion is formed of swelled glands, and the pubic contains the intestine. Fig. 2. is a specimen of inguinal hernia; and fig. 3. of inguino-abdominal.

Plate DXIX.

Fig. 1. Common inguinal hernia, copied from Mr Cooper's plate. *a*, The abdominal ring. *b*, Poupart's ligament. *c*, The femoral artery. *d*, The epigastric artery. *e*, Hernial sac below the ring. *f*, Hernial sac above the ring. *g*, Sharp part of the knife introduced between the ring and the sac, with its side placed towards the sac. Its edge should be turned forwards to divide the stricture. Fig. 2. The hernia on the inner side of the epigastric artery. *a*, The abdominal ring. *b*, Poupart's ligament. *c*, The femoral artery. *d*, The epigastric artery. *e*, Internal oblique and transverse muscles passing over the sac. *f*, Tendon of the transverse muscle passing under it. *g*, Fascia from Poupart's ligament, from which the cord has been withdrawn to shew the place through which it passes. *h*, *i*, The hernial sac. *k*, Knife introduced to shew the manner of dilating the stricture, which Mr Cooper directs always to be done forwards and upwards, opposite to the middle of the mouth of the hernial sac, in all the varieties of inguinal hernia. Fig. 3. Form of the hernial truss; and fig. 4. Mode in which it should be applied.

Plate DXX.

Fig. 1. Crural hernial sac removed, to shew the hole by which it descended in the female. *a*, Seat of the pubes. *b*, Crural arch extending towards the ilium. *c c*, Abdominal muscles. *d*, Crural arch. *e*, Fascia lata.

Explanation of the Plates.

lata. *f*, Semilunar edge of the fascia lata. *g*, Third insertion of the external oblique. *h*, Crural artery. *i*, Crural vein. *k*, Crural sheath. *l*, Abdominal ring. *m*, The orifice by which the crural hernia descends formed on the outer side by the crural sheath; on the inner by the semicircular insertion of the tendon of the external oblique: and above, in part, by the crural, and in part by the semilunar edge of the fascia lata. Fig. 2. A small crural hernia in the female; shewing its passage through the crural sheath, and its distance from the crural arch. *a*, Seat of the symphysis pubis. *b*, Spinous process of the ilium. *c*, Crural arch. *d*, Abdominal ring. *e*, Fascia lata. *f*, Semilunar edge of the fascia lata. *g*, Portion of the crural sheath. *h*, Saphena major vein passing into the crural sheath. *i*, Hernial sac inclosed in its fascia, which is extremely dense, and is proportionably so as the hernia is small. *k*, The hole in the crural sheath through which the hernia passes. Fig. 3. A small crural hernia dissected. *a*, Seat of the symphysis pubis. *b*, Seat of the spinous process of the ilium. *c*, Tendon of the external oblique muscle. *d*, Internal oblique and transversalis. *e*, Fascia of the transversalis. *f*, Tendon of the transversalis. *g*, Inner portion of the fascia transversalis, passing to unite itself with the tendon. *h*, The crural arch. *i i*, Round ligament. *k*, The round ligament passing into the abdomen. *l*, Crural artery. *m*, Crural vein. *n*, Origin of the epigastric artery. *o*, Course of the epigastric artery behind the round ligament. *p*, Crural nerve. *q*, Superficial fascia. *r*, Fascia propria of Mr Cooper, the hernial sac having been drawn into the abdomen to shew this fascia distinctly. Fig. 4. shews the form and mode of applying the truss in femoral hernia.

Plate DXXI.

Fig. 1. An umbilical hernia truss. (*a*), The pad. (*b*), The spring added to the pad. (*c*), An elastic band to assist the pressure of the pad; the lower (*b*) points to the belt which is added to keep this truss in its place in corpulent people. Fig. 2. 3. 4. Different forms of the gorget, as used by Hawkins, Cline, and Cooper. Fig. 5. The staff. Fig. 6. and 7. Different forms of the forceps for the extraction of stones from the bladder.

Plate DXXII.

Fig. 1. A lateral view of the thigh and leg; the dotted lines shewing the direction of the incision in amputation. Fig. 2. An anterior view. Fig. 3. Form of the stump; and, Fig. 4. Mode of applying the circular bandage. Fig. 5. 6. and 7. Retractors. Fig. 8. Pliers for removing any spiculæ of bone. Fig. 9. Head of a trephine, two thirds of the cutting teeth being removed. This instrument is intended for removing the ends of bones, particularly those of the metatarsus and metacarpus. Fig. 10. and 11. Amputating knives. Fig. 12. Amputating saw.

Plate DXXIII.

Fig. 1. Lateral view of the arm and hand, the dotted lines shewing the direction of the incision, in amputation at the shoulder joint and last joint of the fore-finger. Fig. 2. and 3. Saws used in amputations of the hands and feet. Fig. 4. 5. 6. 7. 8. and 9. shew the different parts of an artificial leg. Fig. 11. Cradle used after amputation in order to prevent the bedclothes pressing upon the limb.

Plate DXXIV.

Fig. 1. shews the hare-lip with a fissure of the palate. Fig. 2. The simple hare-lip. Fig. 3. A double hare-lip with two irregular teeth. Fig. 4. shews the part of the lip into which the pins ought to be introduced. Fig. 5. shews the mode in which the ligatures ought to be applied. Fig. 6. The lip after the operation. Fig. 7. and 8. Pins for the lip. Fig. 9. Lip forceps. Fig. 10. Lip forceps, with one blade broader than the other, which is covered with wood in order to make resistance, and not injure the edge of the knife. Fig. 11. Strong scissars for dividing the lip. Fig. 12. Scissars with curved blades, to be used when the lip is very thick, and not easily grasped by the common scissars. Fig. 13. Shews the appearance of the club-foot. Fig. 14. Machine invented by Scarpa for the cure of club-feet. Fig. 15. Distorted foot from a relaxed state of the ligaments, a deformity which may, in general, be removed by wearing a boot, fig. 16. to which is fixed a steel-rod, extending from the sole of the foot to the knee.

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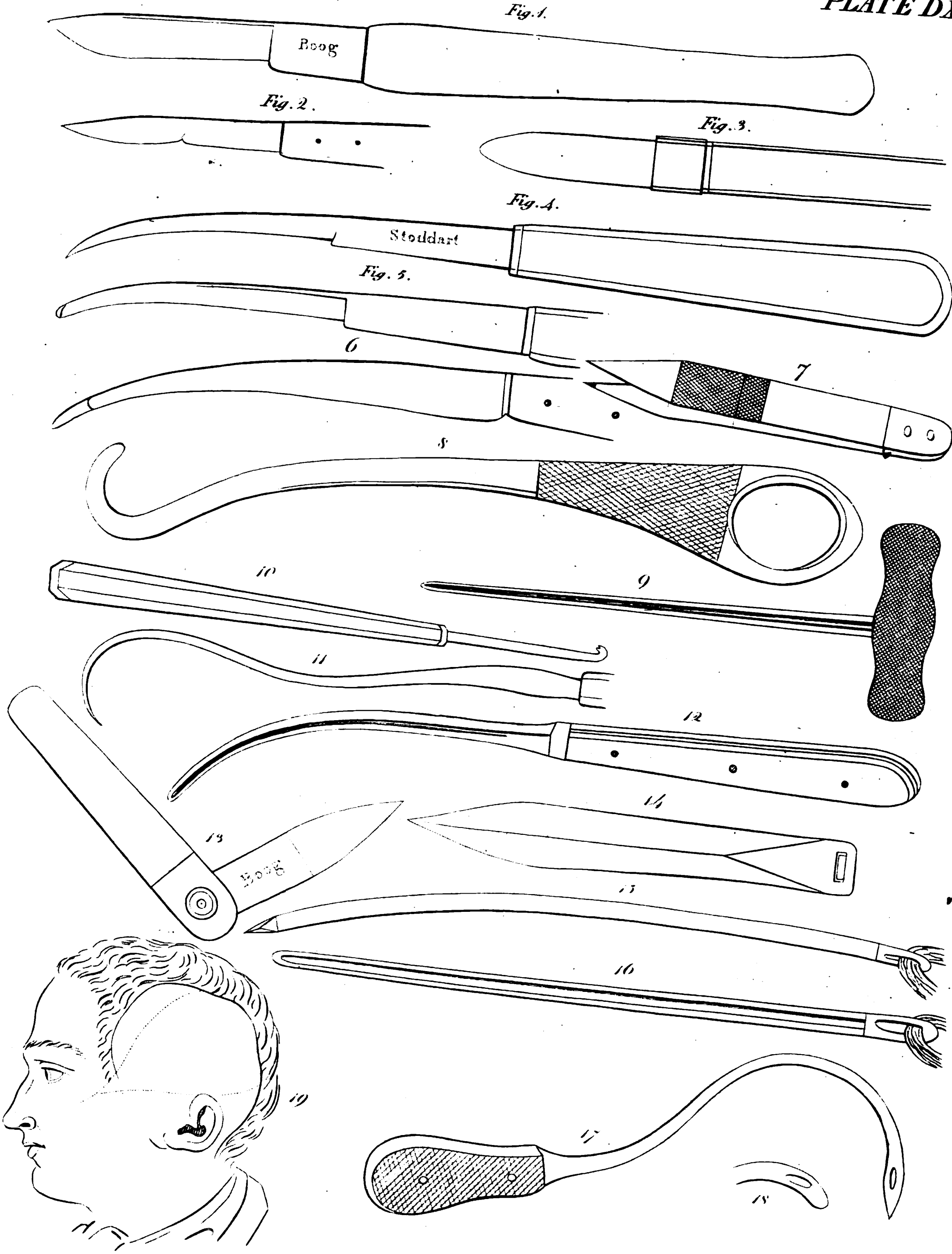
SURINAM.

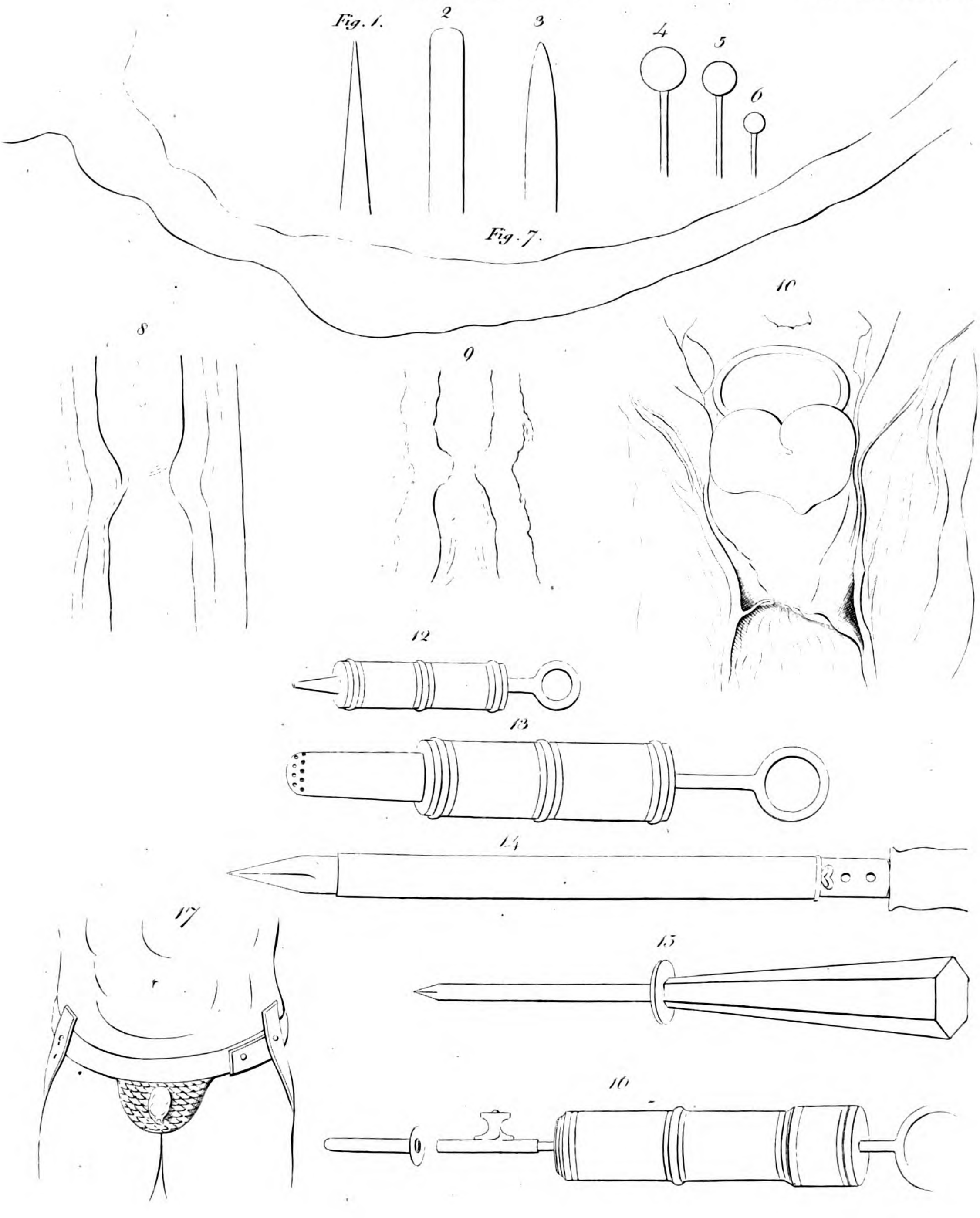
SURGERY.

PLATE DXIII.

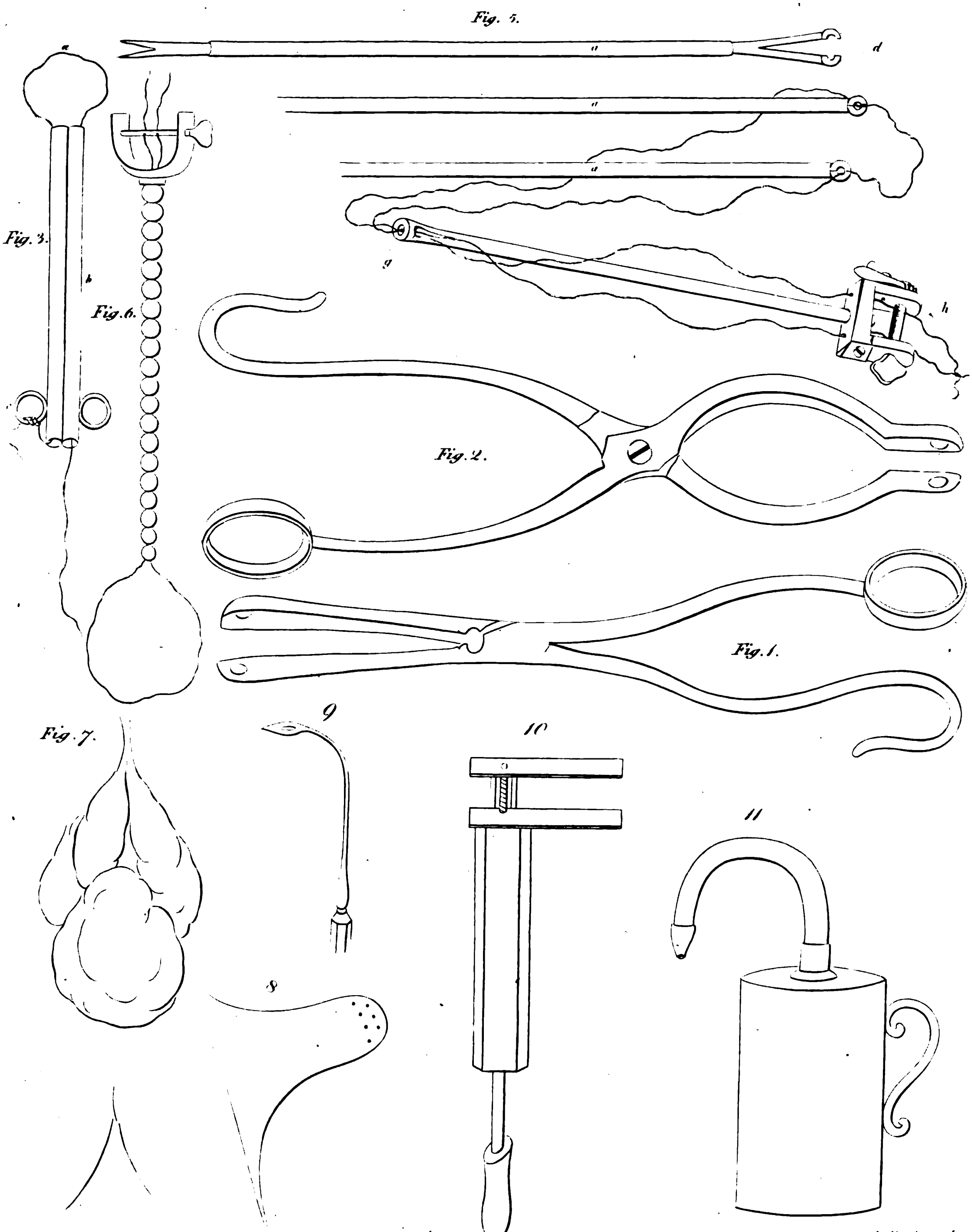


E. Mitchell sculp.

SURGERY. PLATE DXIV.



E. Mitchell sculp.



E. Mitchell sculpt.

Fig. 1.

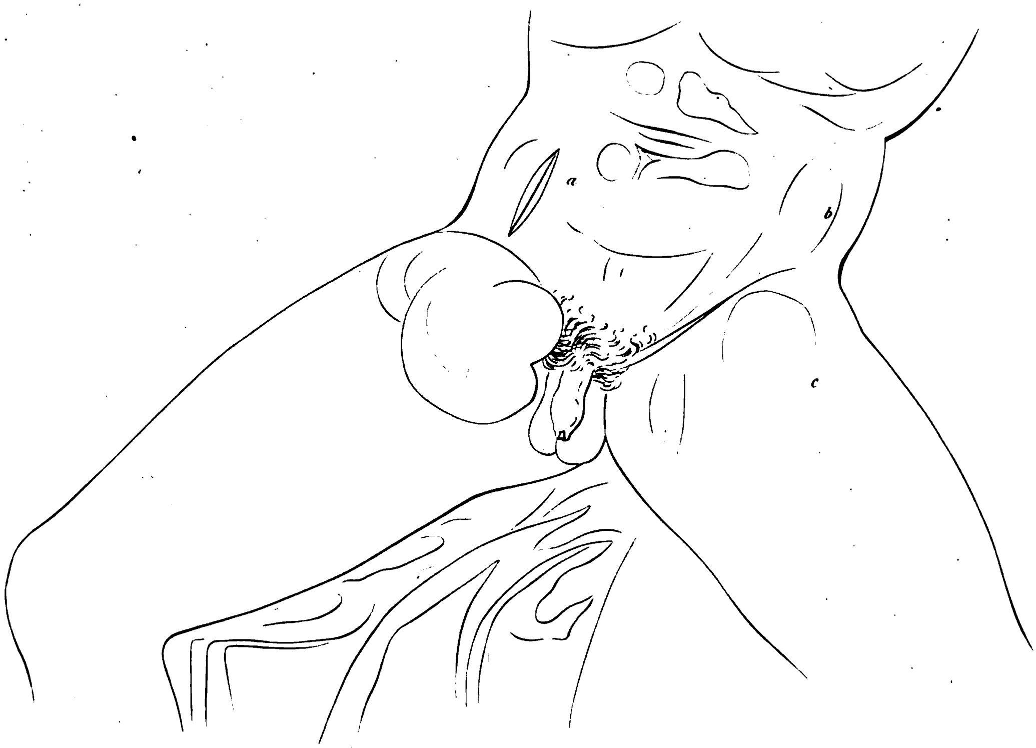


Fig. 2.

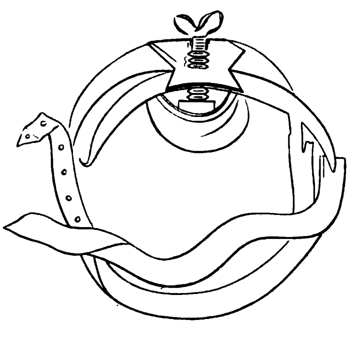
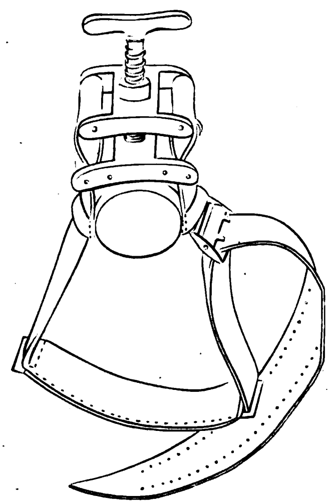
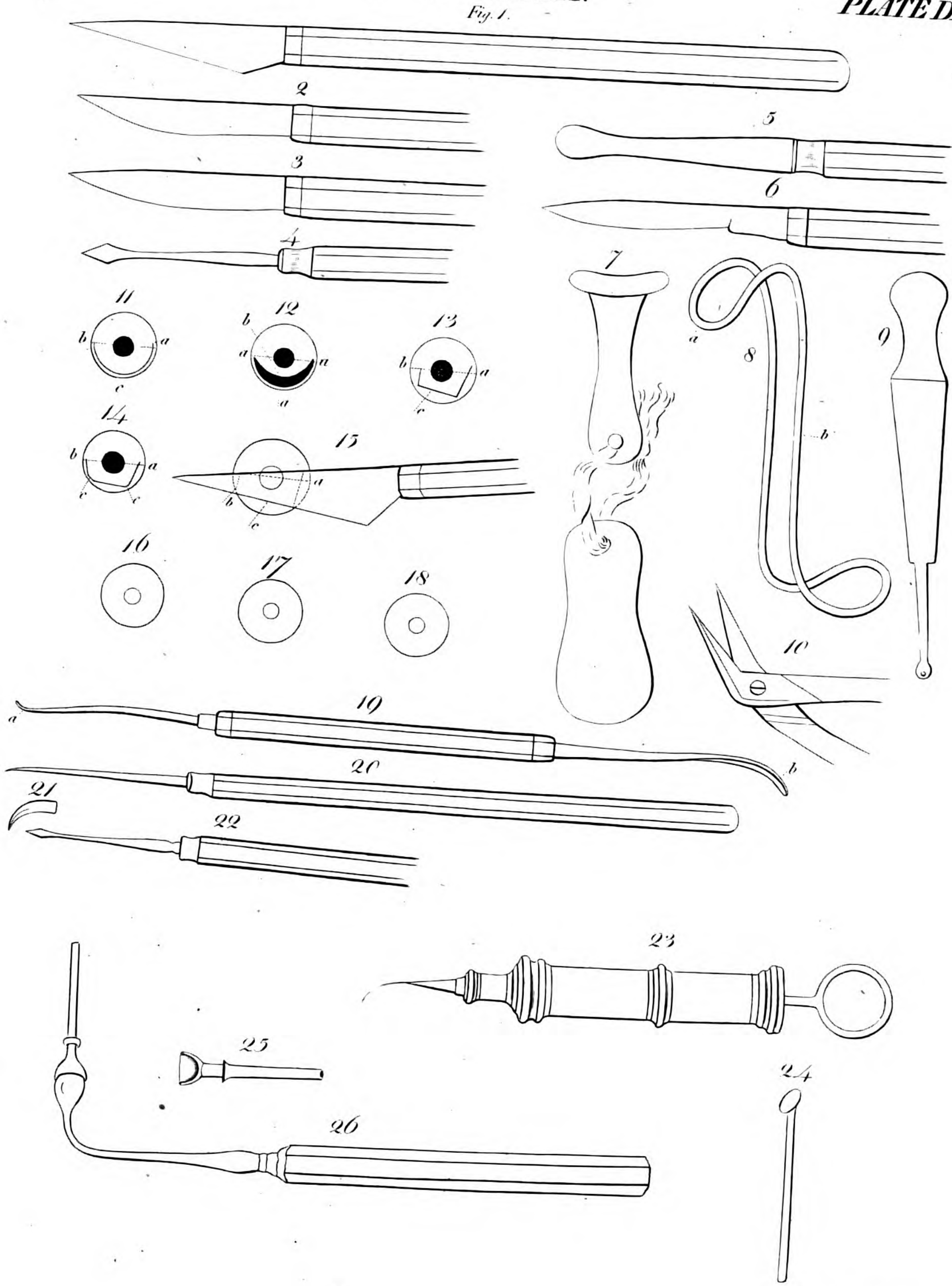


Fig. 3.



E. Mitchell sculpt.



E. Mitchell sculp.

SURGERY. PLATE DXVIII.

Fig. 1.

Femoral Hernia

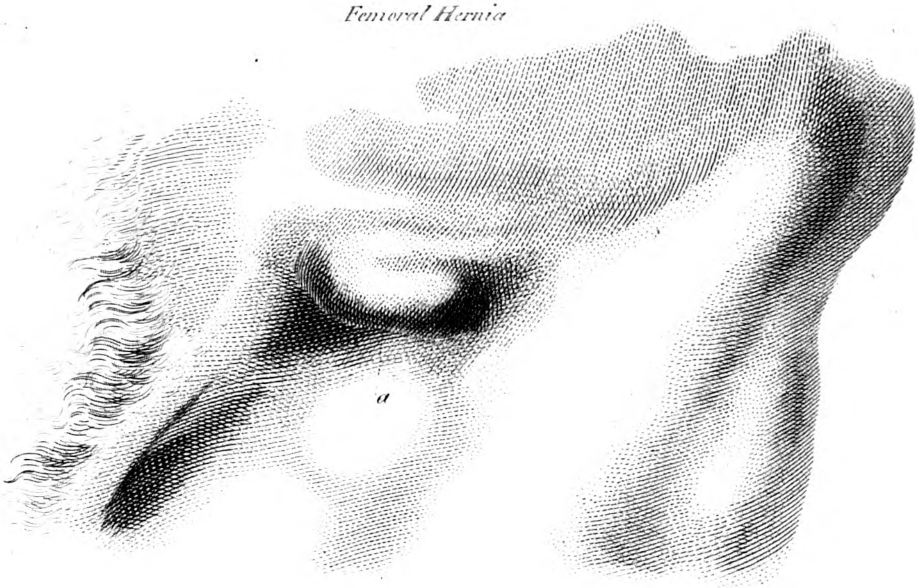


Fig. 2.

Inguinal Hernia

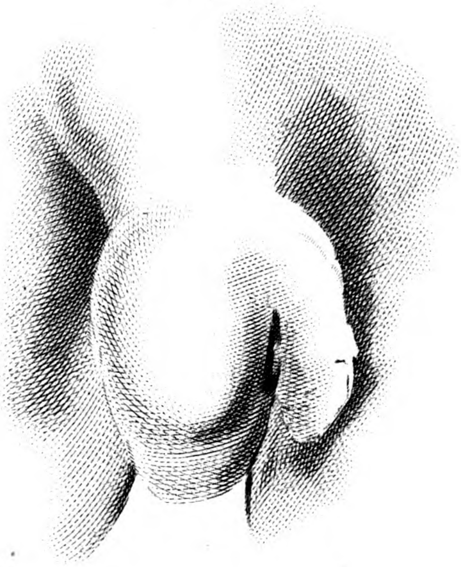


Fig. 3.

Inguinal Abdominal Hernia

E. Mitchell sculp.t

Fig. 1.

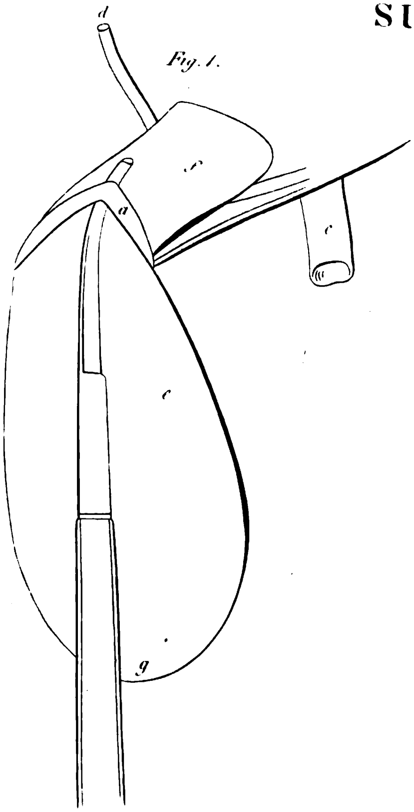


Fig. 2.

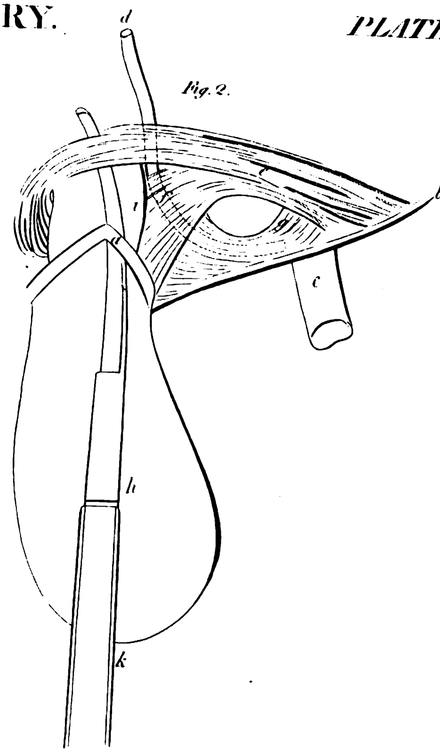


Fig. 3.

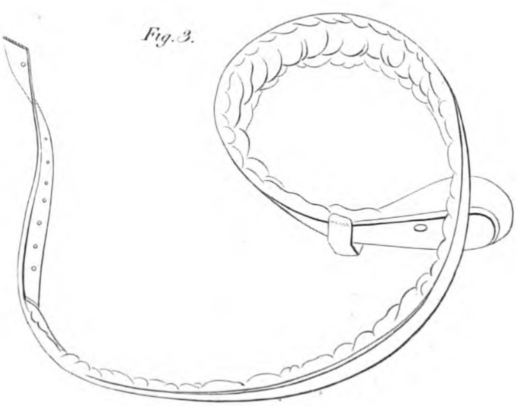
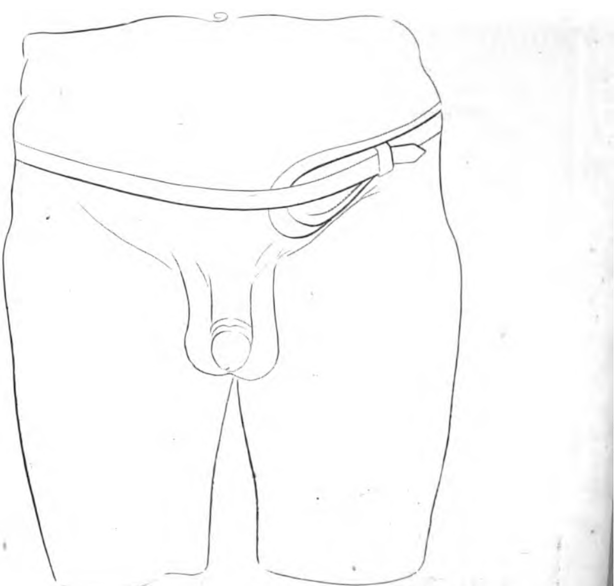


Fig. 4.



E. Mitchell sculpt.

Fig. 1.

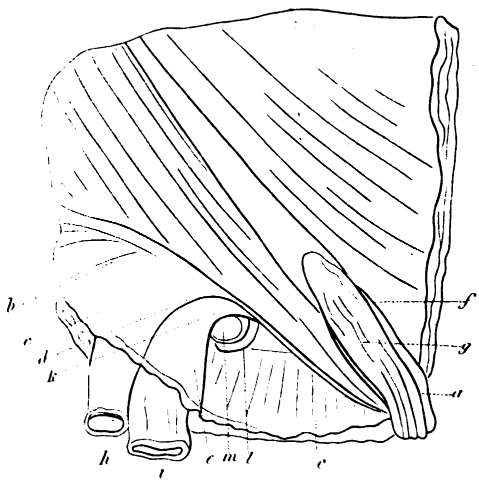


Fig. 2.

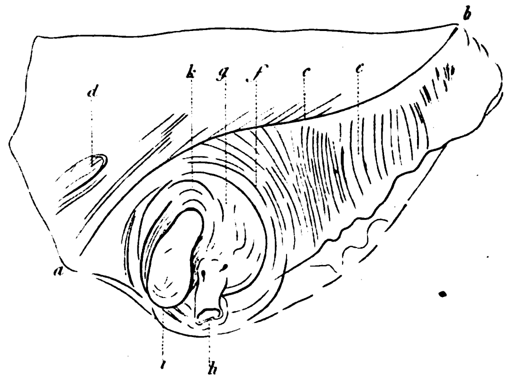
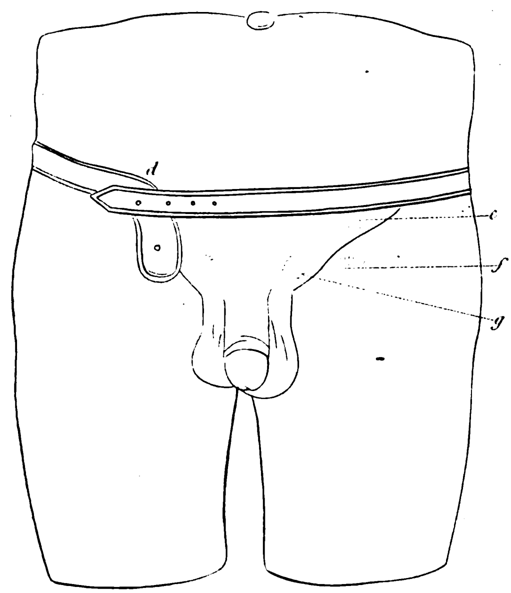


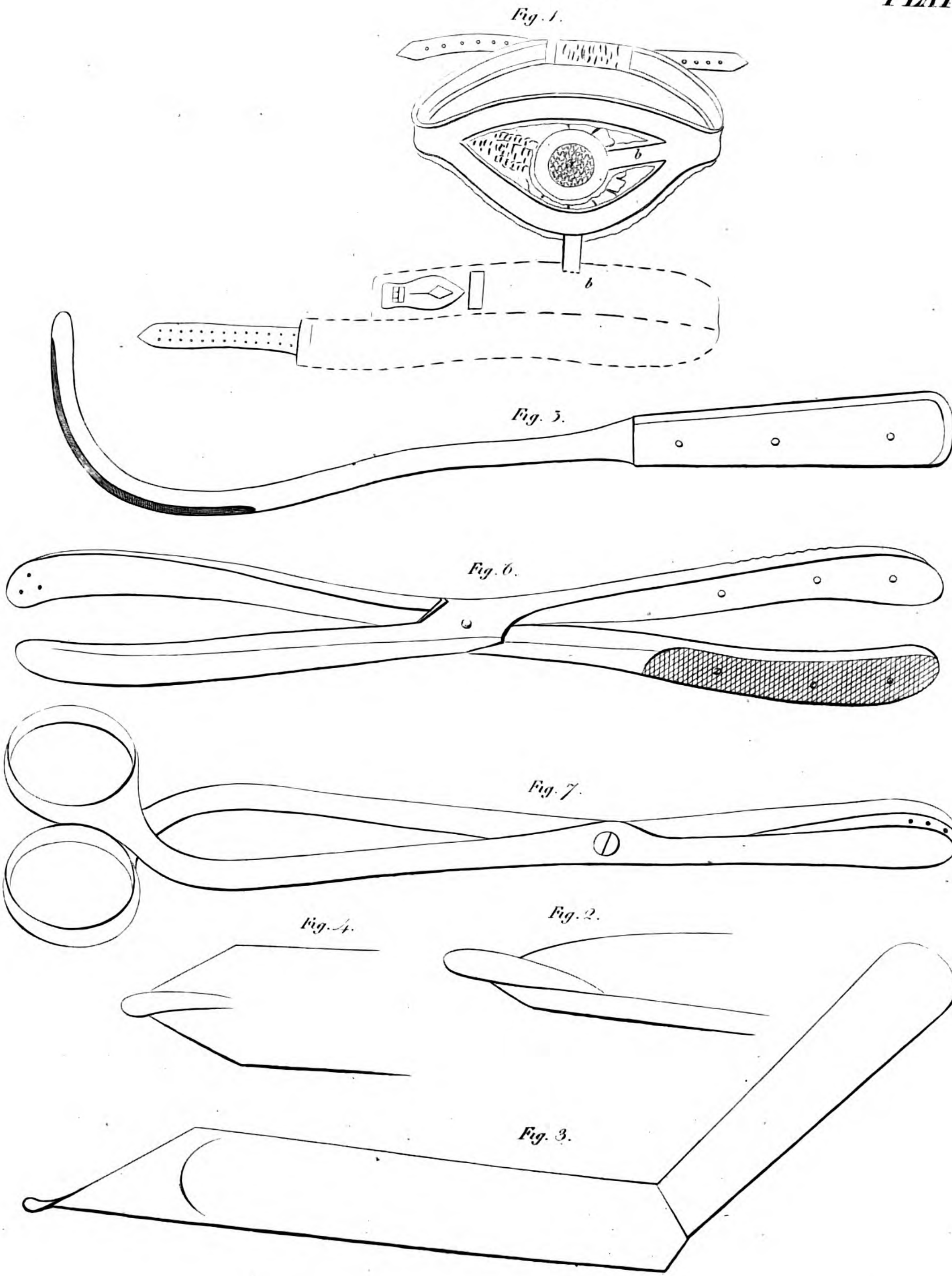
Fig. 3.

Fig. 4.



E. Mitchell fecit

SURGERY. PLATE DXXI.



E. Mitchell sculp.

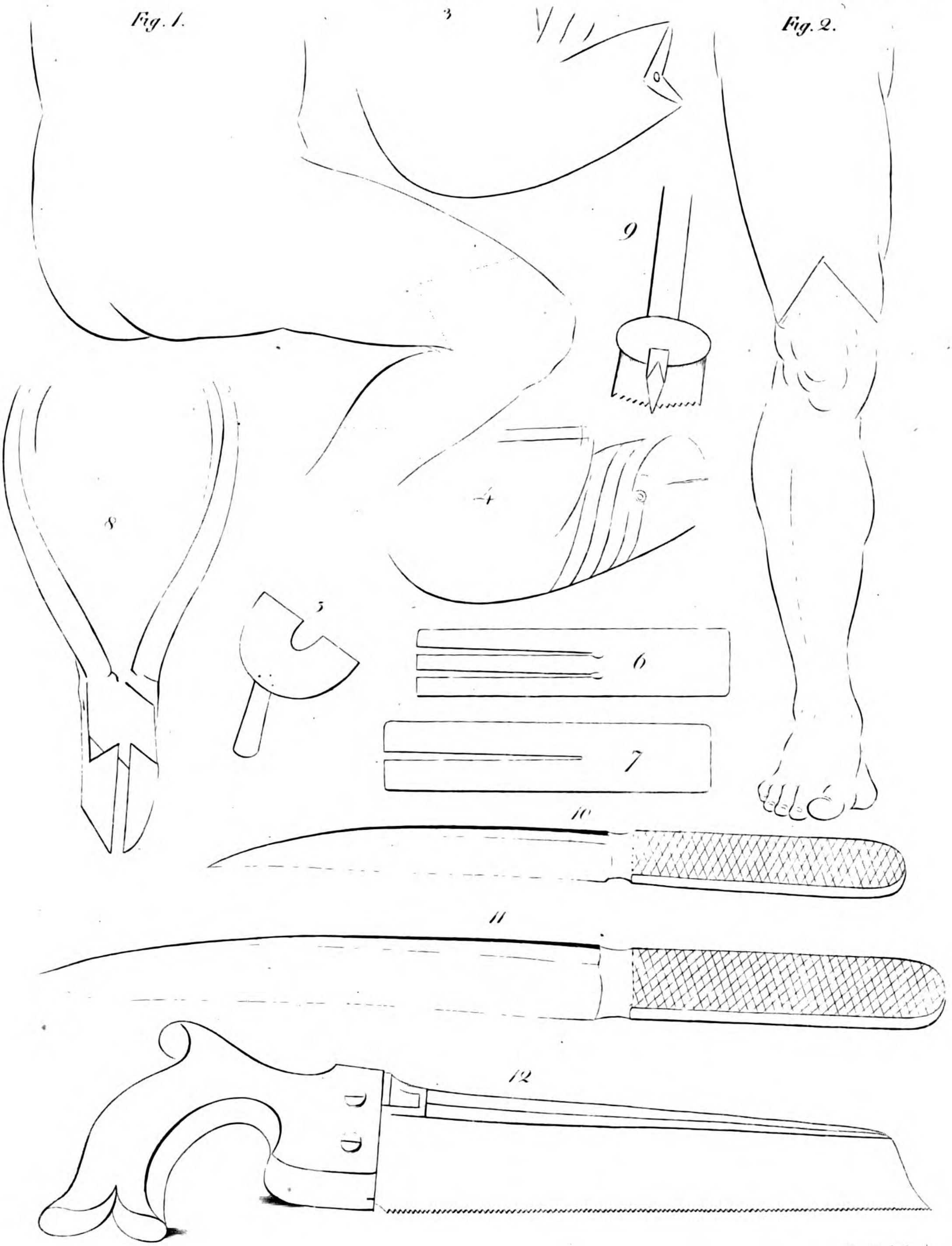


Fig. 1.
3
Fig. 2.
9
4
8
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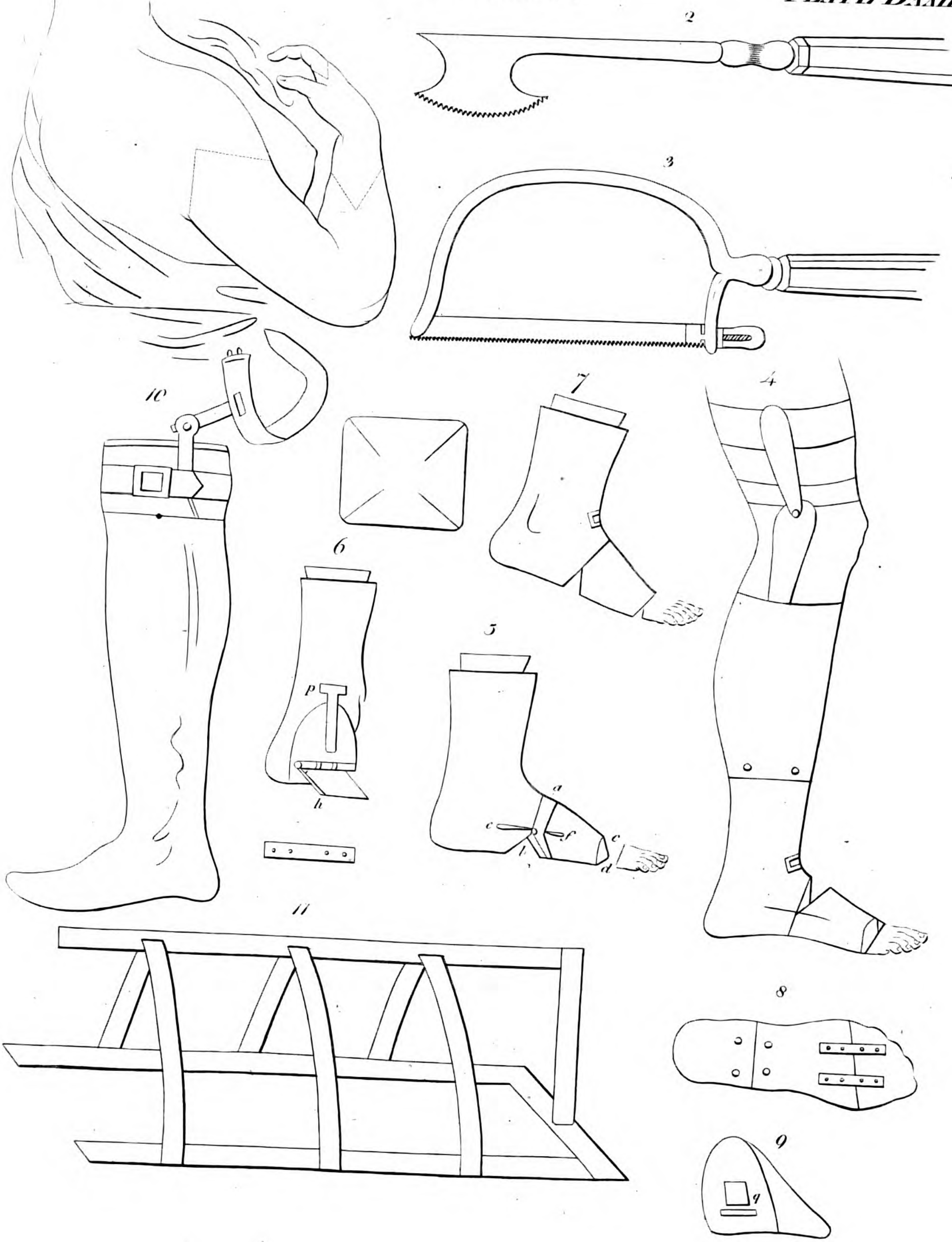
10
11
12

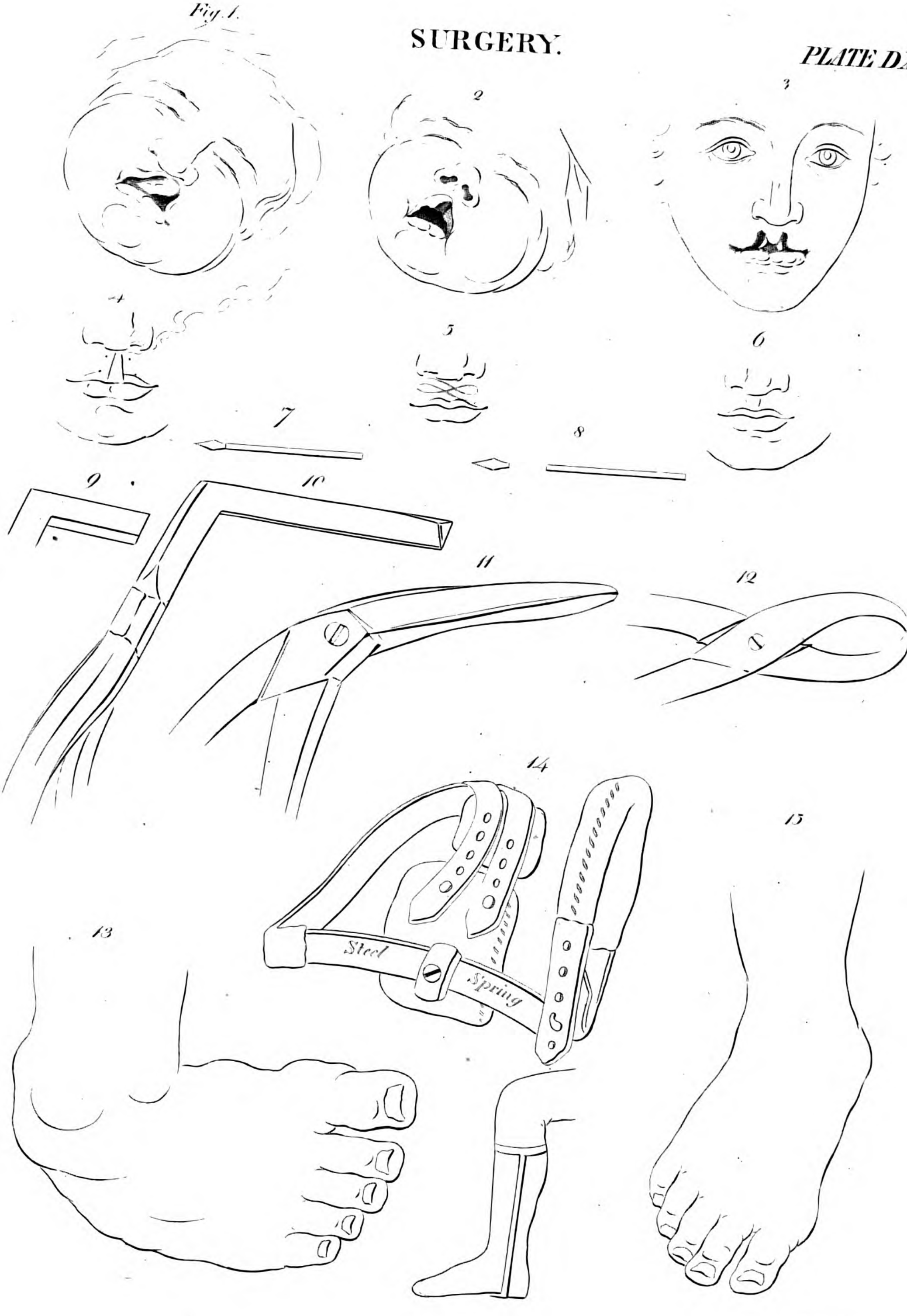
Fig 1



E. Mitchell sc.

SURGERY.

PLATE DXXIV.



E. Mitchell, Sculpt.

SURINAM, a country of Guiana, which extends about 75 miles along a river of the same name, in N. Lat. 6. 16. This river is navigable for 90 miles up the country. The chief productions of Surinam are, wood for dyeing, indigo, cotton, sugar, tobacco, gums, and different species of fruit. Prodigious numbers of monkeys infest the woods, as well as very large serpents. This settlement was ceded to the Dutch in 1674, as an equivalent for New York; was retaken by the British in 1799, and restored in 1814. Paramaribo is the capital. N. Lat. 6. 16. W. Long. 56. 0. The productions of this country, when in the hands of the Dutch, yielded, in the year 1775, the sum of 822,905l. sterling; and it may be presumed that the value of these will not diminish in the hands of its present proprietors. Population about 100,000 persons.

Demerara.—Connected with Surinam we may notice the colony of Demerara, which surrendered to the British troops in 1781; and after some other changes was secured to Britain in 1814, along with Berbice and Essequibo. Its productions cleared from the port of Demerara, from January 1806 to the same month of 1807, were 19 337 hogsheads, 474 tierces, and 801 barrels of sugar; 4722 puncheons and 17 hogsheads of rum; 23,604 bales, two bags of cotton; 12,390,102 pounds of coffee; and 1694 casks of melasses; a produce which we hope will be constantly increasing under the mild and humane conduct of the British government. It is deemed a valuable acquisition, on account of its flourishing condition. Stabroek is the capital of Demerara. See DEMERARA, SUPPLEMENT.

Essequibo, on the banks of a river of the same name, was first founded in 1698, but came into the hands of the British much about the same time with the preceding. The unaccountable neglect shewn by Holland towards her colonies rendered them an easy conquest.

Berbice is situated between Demerara and Surinam, containing about 104 small plantations, scattered at considerable distances from each other, the produce of which was long ago valued at 100,000l. sterling, but may be expected to have a rapid increase. Population between 8000 and 9000 persons of various descriptions. See BERBICE, SUPPLEMENT.

Pomaroon is a country which has a rich and fertile soil; yet the inhabitants chiefly confine themselves to the cultivation of cotton, for the produce of which it is found to be admirably adapted. It is not so well fitted to yield good crops of coffee or sugar, as the land is by far too rich, and strongly impregnated with saline matters. In 1799 and 1800, a thirst for planting cotton was greatly increased, as the crops of that article were then the largest ever known to be produced in the colonies.

SURMOUNTED, in *Heraldry*, is when one figure is laid over another.

SURMULLET. See MULLUS, ICHTHYOLOGY *Index*.

SURNAME, that which is added to the proper name for distinguishing persons and families. It was originally distinguished from *sirname*, which denotes the name of the *sire* or progenitor: thus Macdonald, Robertson, are sirnames expressing the son of Donald, the son of Robert. The word *surname*, again, signified some name superadded to the proper name to distinguish the individual, as Artaxerxes *Longimanus*, Harold *Harefoot*, Malcolm *Canmore*. From this it is evident that every sirname was a surname, though the reverse was not so. In modern times they are confounded; and as there is now no occasion to preserve the distinction, Dr Johnson has rejected the word *sirname* altogether. See NAME.

Surnames were introduced among all nations at an early period, and seem to have been formed at first by adding the name of the father to that of the son. This was the practice among the Hebrews, as appears from the scriptures. Caleb is denominated the son of Jephunneh, and Joshua the son of Nun. That the same thing was customary among the Greeks, every one who has read the poems of Homer must remember. We have an instance of it in the very first line of the Iliad: Αχιλλῆος Πηληιάδεω, "Achilles the son of Peleus." This is perhaps the general origin of surnames, for it has been common among most nations (A).

The Romans generally had three names. The first called *prænomen* answered to our Christian name, and was intended to distinguish the individuals of the same family; the second called *nomen* corresponded to the word *clan* in Scotland, and was given to all those who were sprung from the same stock; the third called *cognomen* expressed the particular branch of the tribe or clan from which an individual was sprung. Thus Publius Cornelius Scipio, *Publius* corresponded to our names John, Robert, William; *Cornelius* was the name of the clan or tribe, as Campbell was formerly the name of all the duke of Argyle's clients, and Douglas the name of the retainers of the duke of Hamilton's progenitors; *Scipio* being added, conveyed this information, that Publius, who was of the tribe of the Cornelli, was of the family of the Scipios, one of the branches or families into which that tribe was divided. Respecting the three names which were common among the Romans, we may say that the first was a name and the other two surnames.

Du Chesne observes, that surnames were unknown in France before the year 987, when the lords began to assume the names of their demesnes. Camden relates, that they were first taken up in England, a little before the conquest, under King Edward the Confessor: but he adds, they were never fully established among the common people till the time of Edward II.; till then they varied with the father's name; if the father, e. gr. was called *Richard*, or *Roger*, the son was called *Richardson*, or *Hodgson*; but from that time they were settled, some say, by act of parliament. The oldest surnames are those we find in Domesday-Book, most of them

(A) This might be supported by examples borrowed from many nations. The old Normans used *Fitz*, which signifies son; as Fitzherbert, Fitzsimmons, the son of Herbert, the son of Simmons. The Irish used *O*; as O'Neal, the son of Neal. The Scotch Highlanders employed *Mac*; as Macdonald, the son of Donald. The Saxons added the word *son* to the end of the father's name, as Williamson.

Surveying. of the field, as B, and a pole, or other mark is to be left at A. The length AB is to be measured by the chain, and a proportional length marked off on the paper, in the direction *a*, *b*, from a plotting scale, or scale of equal parts. Proceeding as at first, a line is to be drawn from *b* towards *c*, in the direction of the side BC, and marking the measure of the angle CBA. In this manner, by placing the plane table successively at each corner of the field or plot of ground, the outline figure of the whole will be transferred to the paper, and *a*, *b*, *c*, *d*, *e*, *f*, will be the plan of the field A, B, C, D, E, F.

If it be not convenient to place the plane table at the corners of the ground to be surveyed, the plan may be taken by placing the instrument any where within the area, as at E (fig. 3.) in the middle of the field A, B, C, D. Fig. 3. In this case we can readily find the direction of the lines EA, EB, EC, ED, and the angles which they form at the point E. By measuring the distances from E to the several angular points, and transferring the proportional distances from the plane scale upon the paper, and then joining the points thus found, there is easily traced the outline of the whole field.

It may happen that no part of the ground to be measured is accessible, except one line, as the line AE in the space A, B, C, D, E, F, G, (fig 4.). Fig. 4.

In this case, the plane table is to be fixed at the point A, of the base line AE, and a point made on some part of the paper at pleasure, to represent the station A, and the base line AE is in the usual manner to be ascertained and laid down. Then from the station A, the situation or direction of the points B, C, D, E, F, G, are to be observed through the sights of the index; and lines corresponding to the lines AB, AC, AD, AE, AF, AG, are to be laid down on the paper, but of an indefinite length. When this is done, great attention must be paid to preserve the table steady and perfectly horizontal. The length of the base line AE being determined, the table is now to be removed to the other extremity E, and so disposed that the base line on the paper may be exactly over the base line EA of the field; and proceeding as before, the directions of the lines EA, EB, EC, ED, EF, EG, are to be determined, and corresponding indefinite lines drawn on the paper. The points where these last lines cross those before traced, are to be carefully noted, and the outline joining all these points of section, will correspond to the outline of the plot to be surveyed.

The following general directions to be observed in using the plane table, are given by Dr Hutton. 1. Let the lines on which stations are made be directed towards objects as far distant as possible; and when any such object is set, go round the table and look through the sights from the other end of the index, to see if any other remarkable object be directly opposite; if there be none such, endeavour to find another forward object, such as shall have a remarkable backward opposite one, and make use of it, rather than the other; because the back object will be of use in fixing the table in the original position, either when you have measured too near to the forward object, or when it may be hid from your sight at any necessary station by intervening hedges, &c.

2. Let the said lines, on which the stations are taken, be pursued as far as conveniently can be done; for that will be the means of preserving more accuracy in the work. Surveying.

3. At each station it will be necessary to prove the truth of it, that is, whether the table be straight in the line towards the object, and also whether the distance be rightly measured and laid down on the paper. To know whether the table be set down straight in the line, lay the index on the table in any manner, and move the table about, till through the sights you perceive either the fore or back object; then, without moving the table, go round it, and look through the sights by the other end of the index, to see if the other object can be perceived; if it be, the table is in the line; if not, it must be shifted to one side, according to your judgement, till through the sights both objects can be seen. The aforesaid observation only informs you if the station be straight in the line; but to know if it be in the right part of the line; that is, if the distance has been rightly laid down: fix the table in the original position, by laying the index along the station line, and turning the table about till the fore and back objects appear through the sights, and then also will the needle point at the same degree as at first. Then lay the index over the station point and any other point on the paper representing an object which can be seen from the station; and if the said object appear straight through the sights, the station may be depended on as right; if not, the distance should be examined and corrected till the object can be so seen. And for this very useful purpose, it is adviseable to have some high object or two, which can be seen from the greatest part of the ground accurately laid down on the paper from the beginning of the survey, to serve continually as proof objects.

When from any station, the fore and back objects cannot both be seen, the agreement of the needle with one of them may be depended on for placing the table straight on the line, and for fixing it in the original position *. * See Hutton's Mensurer.

5 Method of measuring offsets. The foregoing examples are extremely simple, as the bounding lines are straight and regular. Here, therefore, it is not requisite to measure what surveyors call the offsets, or the perpendicular distances between a base line, and the several angles which it subtends. It seldom happens, however, that the work can be carried on in so regular a way, as the bounding lines, even of small pieces of ground, are generally more or less crooked.

Let us suppose A, *l*, *m*, *n*, *o*, *p*, *q*, *r*, (fig. 5.) to be a crooked hedge, or other boundary of a piece of ground, and AB the general base line subtending its several angles. Fig. 5. In measuring along this base, when the surveyor comes opposite to any of the bendings or corners of the fence, as at *c*, *d*, *e*, &c. he measures the perpendicular offsets *cl*, *dm*, *en*, &c. either with the offset staff, or, if they are of considerable length, with the chain. These offsets are to be noted down, as will be explained immediately.

When the offsets are not very large, their places may be determined pretty exactly by the eye, especially when assisted by laying down the offset staff in a direction perpendicular to the base, and opposite to the angles; but when the offsets are very large, their positions are best determined by the cross, or the plane table, in the following manner. In measuring along AB (fig. 5.), when

Surveying.

when coming nearly opposite to *l*, where an offset is likely to stand, the cross or plane-table is there to be fixed, as at *c* in the line A B, and its index is to be turned till the extremities of the base A and B can be seen through the sights, both backward and forward. Then looking along the cross sights of the cross, or the cross line on the index of the plain table, it is easy to observe whether the station of the instrument be exactly opposite to the corner. If it be not, the instrument must be moved backward or forward along the line A B, preserving the index in the same situation till the station and the point *l* be exactly opposite to each other. The exact measured distance between A and *c*, is then to be noted and registered, and the measure of the offset *c l* is to be set down opposite to the former, and on the left hand of it, as the work is advancing from A to B. In the opposite direction the offsets would of course appear on the right hand. In this method, no field book or register is usually necessary, but where the survey is more extensive, and where the theodolite or other complex instruments are required, it is necessary to have recourse to some method of registering the successive operations.

6 Use of the field-book.

The field book employed on these occasions is variously constructed, according to the taste or particular object of the surveyor. The following is a specimen of the usual field book, as described by Dr Hutton.

Offsets and remarks on the left.		Stations, Bearings, and Distances.	Offsets and remarks on the right
		⊙ 1	
		105° 25	
		00	25 corner.
	92	73	
		248	Brown's hedge.
Cross a hedge,	24	610	35
		954	00
		⊙ 2	
		53° 10′	
		00	00
House corner,	51	25	21
		120	29 a tree.
	34	734	40 a stile.
		⊙ 3	
		67° 20′	
		61	35
A brook,	30	248	
		639	16 a spring.
Footpath,	16	810	
Cross hedge,	18	973	20 a Pond.

Of the three columns which compose this field book, the middle or principal column is for noting down the stations, angles, bearings and distances, as they are ascertained, and the columns on the right and left are for the offsets to the right and left of the principal course, which are placed against their corresponding distances in the middle column, as also for occasional remarks or memorandums, to which it may be useful to refer in drawing the plan of the surveyed lands.

Here ⊙1 is the first station, where the angle or bearing is 105° 25′. On the left, at 73 links in the distance or principal line, is an offset of 92; and at 610 an offset of 24 to a cross hedge. On the right, at 0, or the beginning, an offset 25 to the corner of the field; at 248 Brown's boundary hedge commences; at 610 an offset 35; and at 945, the end of the first line; the 0 denote its terminating in the hedge. And so on for the other stations. A line is drawn at the end of every station line, to prevent confusion.

7 Crocker's field-book.

Various improvements have been made on the field-book, especially by Mr Abraham Crocker, and Mr John Bodham. We shall give a specimen of each.

Fig. 6.

Fig. 6. represents a page of Mr Crocker's field-book, exhibiting a part of the survey of an estate called the Mill Estate; the outlines of which were surveyed with the theodolite, and the interior parts filled up with the chain. In this book the operations are noted down, so as to begin from the foot of the page, carrying them on upwards.

In surveying after this method, Mr Crocker advises to choose two or more eminences, as principal stations, and measure a general base line from one station to the other, noting each hedge, brook, or other remarkable object as it is passed by; measuring also such short perpendicular lines to such bends of hedges as may be near the base. From the extremities of this base line, or from any convenient parts of it, the surveyor must proceed with other lines to some remarkable object situated towards the sides of the estate, without regarding the angles they make with the base-line or with one another, remembering to note every hedge, brook, or other object by which he passes. These lines, when laid down by intersections, will with the base line form a principal triangle on the ground to be surveyed; several of which, if necessary, being thus laid down, the surveyor may proceed to form other smaller triangles and trapezoids, on the sides of the former; and so on till the several enclosures are finished.

This principal triangle being completed, and laid down on the rough plan paper, the parts, exterior as well as interior, are to be completed by smaller triangles and trapezoids.

When the whole plan is laid down on paper, the contents of each part of the estate may be calculated by the methods already explained under MENSURATION.

In countries where the lands are enclosed with high hedges, and where many lanes or roads pass through an estate, a theodolite may be employed with advantage, in ascertaining the angles of such lands; and by these means an outline of the estate may be obtained, and the lane lines serve as the bases of such triangles and trapezoids as are necessary to fill up the interior parts.

Plate DXXVI. fig. 8.

To illustrate this method, let us take AB in the plan of the estate, (fig. 8) for the principal base line. From B go off to the tree at C, noting down in the field book every cross hedge as you measure on, and from C measure back to A, noting down every thing remarkable, as before directed. This figure also illustrates the method of measuring the cross lines, offsets, and interior parts and enclosures.

8 Rodham's field book, Fig. 7. and 9.

Fig. 7. represents a page from Mr Rodham's field book. His method of procedure is as follows:—Like Mr Crocker, he begins from the bottom of the page, and writes upwards; denoting the crossing of fences, by lines

Surveying. lines drawn across the middle column, or only a part of such a line on the right and left opposite the figures, to avoid confusion, and the corners of fields, and other remarkable turnings in the fences, towards which offsets are taken, by lines joining like the fences, as will be best seen by comparing the specimen at fig. 7. with the plan at fig. 9.

The marks called *a*, *b*, *c*, &c. are best made in the fields, by making a small hole with a spade, and placing there a chip or small piece of wood, with the particular letter marked on it, to prevent one mark being taken for another, on any return to it, though in general the name of a mark is very easily seen, by referring in the book to the line in which it was made. After the small Italic letters have been gone through, the capitals may be next employed, and the Roman letters afterwards, and so on. Perhaps it would be preferable to distinguish the marks by figures.

The letters in the left hand corner at the beginning of each line, denote the mark or place measured *from;* and that at the right hand corner of the end, is the mark measured *to.* But when it is not convenient to go exactly from a mark, the place measured from is described *such a distance* from *one mark* towards *another;* and where a mark is not measured to, the exact place is ascertained by writing, turn to the right or left hand, *such a distance* to *such a mark*, it being always understood that those distances are taken in the chain line.

The characters used are for ⌈ *turn to the right hand*, ⌉ for *turn to the left hand*, and ʌ placed over an offset, to shew that it is not taken at right angles with the chain line, but in the line with some straight fence, being used chiefly when crossing their directions, and is a better mode of ascertaining their true places than by offsets at right angles.

When a line is measured whose position is determined, either by former operations (as in the case of producing a given line or measuring from one known place or mark to another) or by itself (as in the third side of a triangle) it is called a *fast line*, and a double line is drawn across the book at the conclusion of it; but if its position be not determined (as in the second side of a triangle) it is called a *loose line*, and a single line is drawn across the book. When a line becomes determined in position, and is afterwards continued, a double line is drawn half through the book.

Fig. 9. When a loose line is measured, it becomes absolutely necessary to measure some line that will determine its position. Thus, the first line *a b*, (fig. 9.) being the base of a triangle, is always determined, till the third side *j b* is measured; then the triangle may be constructed, and the position of both is determined.

At the beginning of a line to fix a loose line to the mark or place measured from, the sign of turning to the right or left hand must be added (as at *j* in the third line); otherwise a stranger, when laying down the work, may as easily construct the triangle *h j b*, on the wrong side of the line *a h*, as on the right side; but this error cannot be committed, if the sign above named be carefully observed.

In choosing a line to fix a loose one, care must be taken that it does not make a very acute or obtuse angle, as in the triangle *p* B *r;* by the angle at B being very obtuse, a small deviation from truth would make the error at B when constructed very considerable; but by constructing the triangle *p* B *g*, such a deviation is of no consequence.

When the words *leave off* are written in the field book, it is to signify that the taking of offsets is from thence discontinued; and of course something is wanting between that and the next offset *.

9 Practical directions for the use of the theodolite. The general use of the theodolite in measuring separate plots, has been described under MENSURATION. The following practical directions for the use of this instrument are given by Mr Crocker, and apply to his field book, exemplified at fig. 6. and the plan at fig. 10.

Suppose the surveyor to plant his theodolite in the road ⊙ 1, and having duly adjusted it, by placing its head exactly horizontal, by the levels; and setting the index part of the limb exactly at 360°; and by moving the whole head about till 360° in the compass-box comes to the line in the north end of the needle; there fixing all fast, by the screw under the head, between the legs, he will have his instrument completely adjusted.

Fig. 10. The theodolite thus adjusted, the surveyor sends one of his assistants forward as far as he can conveniently see how to measure a straight line, as at ⊙ 2. Taking then his angle of observation, by his telescope, to the picket at that station, he finds it to be 69° from the north part of his magnetic meridian line towards the east, which he enters in his field book, noting it with NE, as a memorandum on which side of the magnetic meridian it lies. He is now to fasten his limb to the other part of the head, by a screw for that purpose.

His chain-man having laid the chain in the direction to the picket ⊙ 2, in order to measure the line, he makes such offsets to the right and left, in his first chain's length, as may be necessary. At his first station, he finds that on the right, the general road fence is 30 links, and also a nook of 40 links more, and 30 links broad; and that on the left of his station he has an offset of 10 links, all of which he must note in his field book. Proceeding forward on this line, he finds at 300 he has an offset of 25 on the right, where is a gate, which he has to notice; and, on the left 20, which determines the breadth of the road at that spot. At 400, he will find 10 on the right and 20 on the left to be the breadth; and at 700 (the end of the line) he will find 35 on the right and 15 on the left to be the breadth of the road; where also he will find a small road branching off to the right. Thus the first station line is finished.

To this spot (which is his second station) he brings the theodolite; and after setting it level, he unlocks the under screw, and turns the whole head about, till, through the telescope, he sees the back picket or station staff to be cut by the cross hairs. Here, again, locking the head of his theodolite firm by the under screw, he must unscrew the limb, and turn it about, till through the telescope, he has a view of the picket at ⊙ 3; the bearing of which he will find to be 253° 10′ from the north to the eastward, which he will enter in his field book. Measuring on from ⊙ 2, towards ⊙ 3, he will find at 130 links, that he is come to a turnpike, where the breadths at the right and left are 30 and 15. At 200, he has an offset of 15 on the left, and a break off at the right of another road, at 25 from his line, with two other offsets, as expressed in the field book. It must

* Hutton's Math. Dict. art. Surveying.

Surveying. must be noted where this road leads to. At 265 he has offsets of 30 on the left, and 20 on the right. Thus ends the second station line.

Now bringing his instrument to ⊙3, he is to adjust it in the manner before directed at ⊙2; and turning the limb about towards the picket forward, he will find the angle of bearing to be 57° 45′, still from the north to the eastward. At 20 links he will be opposite to a cross hedge on the left, belonging to the estate he is surveying. At 293 he ends the line of this station, where the offsets are 5 and 35, as noted in the field book.

Coming next to ⊙4, and having adjusted his theodolite, he finds his next angle =226° NE. At 120 his offsets are 20 and 15. At 410, they are 15 and 30, where, on the left, is a cross hedge, of a backward direction. At 480 his offsets are 5 and 25, where is another cross hedge. At 750, is a break-in of the fence, and the offsets are 30+15 on the left, and 10 on the right. At 1050, the offsets are 20 on each hand, and another cross hedge on the left. At 1150 are offsets of 20 and + 20, where stands a house. At 1300, the offset of 30 on the right terminates the house; and at 5 on the left is a cross hedge, of a backward direction. 1350 ends this line, where roads diverge to the right and left.

At ⊙5, the instrument being adjusted, the angle is found to be 284° 50′ nearly W. At 50, his offset to the hedge is 15; at 220 it is also 15, where is a cross hedge, the other end of which was noted at 1050 in the last line. At 320 the offset is 25; at 350, the end of the ⊙, the distance from the fence is 15.

At ⊙6, the bearing is 305° 35′ N. W. At 130 the offset is 30, where a cross hedge goes off to the point which was noted at 750, in the line from ⊙4 to ⊙5. At 160 the line is nearly close to the fence, ending at 210.

At ⊙7, the angle forward is 106° 25′ N. W. The line is 143 long, with an offset at the end of 15.

At ⊙8 the bearing is 269° 20′ N. W. At 100 and at 300 the offsets are 15 and 10.

The bearing at ⊙9 is 70° 45′ S. W. At 30 the measurer finds it expedient to cross the fence, and proceed within the bounds of the estate. At 90 he has an offset of 30 to the right, where he crosses a hedge. At 880 he crosses another hedge, having there an offset of 20: at 940 is an offset of 50. At 990 he again crosses the hedge; and at 1020 is an offset of 20 to the left: at 1040 he again crosses the hedge: at 1080 he comes to the corner of the farm house; and 1165 ends his line, where is a small curve at the right.

At ⊙10, the bearing is 204° S. W. At 70 is an offset of 5 at the right: at 200 is 15 at the left, and a cross hedge: at 600 is 25 on the left, and 20+15 on the right: 690 ends the line, where are 15 on each side, where there is also a cross hedge.

The angle at ⊙11 is 355° 30′ S. E. At 280 is an offset of 30 on the right, and 10 with a cross hedge on the left: at 400 is an offset of 30, and another cross hedge on the left; and 470 ends the line, where are offsets of 10 and 20 on the right and the left.

At ⊙12 the angle is 155° S. E. At 60 is a cross hedge: at 219 the offsets are 10 and 15; and at 229 he comes to close his work at ⊙1, from which he set out.

Having thus taken the circuit of this estate, the measurer must proceed to plot the same on paper, with some convenient scale *.

* Crocker's Elements, p. 235.

10 Description and use of the plotting-scales. Figs. 11. and 12.

The scale usually employed for this purpose is that called the *plotting scale*, *plane scale*, or *scale of equal parts*, represented at fig. 11. and 12.

This instrument contains different scales or divided lines, on both sides. There are on one side a number of plane scales, or scales of equal divisions, each of a different number to the inch, and also scales of chords for laying down angles, and sometimes the degrees of a circle marked on one edge, answering to a centre marked on the opposite edge, by which means it also answers the purpose of a protractor. There are several diagonal scales on the other side, of different sizes, or different dimensions to the inch, serving to take off lines expressed by numbers to three dimensions, as units, tens, hundreds, as also a scale of divisions which are the 100th parts of a foot. The most useful of all the lines which can be laid down on this instrument, though not always done, is a plane scale on the two opposite edges, made thin for the purpose. This line is very useful in surveying; for by laying down the instrument on paper, with its divided edge along a line whereon several distances are to be laid off, for the places of offsets, &c.; these distances are all transferred at once from the instrument to the line on the paper, by making small points or marks against the respective divisions on the edge of the scale.

11 Directions for plotting or planning.

The business of *plotting* or laying down a plan of an estate from the memoranda of a field book, is a very important branch of the surveyor's office. This will best be understood by an example, which we shall take also from Mr Crocker. It is adapted to the page of his field book, already alluded to; and the plan, when completed, is seen at fig. 10.

The vellum or paper on which the plan is to be drawn, being smoothly laid on a drawing board, the magnetic meridian is to be represented by a line drawn from the bottom to the top.

A point is to be made about the middle of this line, on which is to be laid the centre of the circular protractor, placing the straight edge in such a manner as to coincide with the said meridian line: draw a pencil line around at the edge of the protractor.

The protractor being thus placed, and firmly fixed by means of pins in that position, or by a lead weight, the field book is to be inspected for the quantity of the angle at ⊙1, which, in the present case is stated at 69° north-easterly. This degree is then to be looked for on the circular edge of the protractor, and a mark made on the paper with a fine plotting-pin, at that number, which is to be marked 1, denoting ⊙1.

The field-book is then to be inspected for the ∠ at ⊙2, which in this case is 253° 10′, where a mark is to be made as before.

A similar process is to be followed with all the other angles, till the surveyor comes to the close on ⊙1.

All the angles being thus marked off, the protractor is to be removed.

The place where the beginning of the work should be placed is then to be considered, that the whole may come within the compass of the paper laid down; where a mark is to be made, noting it as ⊙1, the beginning of the plot.

The fore edge of the parallel ruler is then laid from the

Surveying.

the central point where the protractor lay, to the mark on the pencilled circle denoting ⊙ 1. The fore edge of the parallel ruler is next moved till it touch the point determined on for the beginning of the plot, from which a pencil line in the direction from the north to the eastward, is drawn, about the length of the whole line of this ⊙ = 760.

A feather-edge scale is applied to this pencil or obscure line, the 0 division of it at the beginning, marking off every progressive number where any offsets have been made, as at 300, 400, and 760.

The scale is then turned across the line (by some cross division), and the offsets on each side of the station line are pricked off. At 0, or ⊙ 1, the field book shows that on the left hand, at 10 links, is the boundary line of that side, where there is likewise a small road branching off. The offset on the right hand is 30, which, with + 40, goes to the extent of a small corner, also 40 links in breadth. At 300 on the left there is an offset of 20, and on the right another of 25, where there is also a gate to be noticed. At 760 there is an offset on the left of 15; and on the right, one of 35, where a small roadway branches off. All these offsets are to be pricked off as the surveyor proceeds. The boundary lines are drawn through these offset points, and in this manner the first station is completed.

The parallel ruler is then laid from the centre to the angular point of ⊙ 2; the limb of it is moved till it touches the end of the last station line, from which another obscure line is drawn, from the north-easterly, as noted in the field book.

The edge of the scale is then applied as before, and the numbers 30, 200, and 265 are pricked off. There is a toll gate at 30 links, and a lane of 30 links broad, going off at an acute angle. At 265, the end of this station, the offsets are 30 and 10.

The line from ⊙ 3 is then laid off, as before directed, north-easterly, and the numbers 20 and 293 are pricked off. Opposite to 20 is a hedge branching off to the left, and at 293 the offsets are 35 and 5.

The line north easterly is laid off from ⊙ 4, and the numbers on that line are pricked off as they appear in the field book, and the offsets are made as follows. At 120, 15 and 20 are set off; at 410 are 30 and 15, where two hedges branch off nearly in the direction of the side sketches. At 480 the offsets are 25 and 5, where there is a cross hedge on the left. At 750 on the left, is 30 + 15 with a cross hedge, and on the right 10. At 1050 on the left, is 20 with a cross hedge, and 20 on the right. At 1150 on the right, is 20 + 20, where stands a house. At 1300 on the left, is 5 with a cross hedge; on the right is 30, with a road branching from it; 1350 completes this line.

At ⊙ 5 the work takes another direction, and goes backward towards the west. The ruler is laid from the centre to this station, and an obscure line drawn in the direction mentioned. The distances and offsets are pricked off as in the field book. Here are offsets on one side only, not being in a road way.

At ⊙ 6 set off the line south-westerly, pricking off the distances and offsets as in the field-book.

This specimen is sufficient to give a complete idea of the practice of plotting; and more would be only a tedious repetition. It must, however, be observed, that the accuracy and facility of the work greatly depend on the judgment and care exercised in keeping a correct and clear field-book.

Surveying

When a circuit is plotted off, the measurer must fill up the interior, by separately completing the measure of each field with the chain, so that they may be laid down on the plan in their proper situations and dimensions. The lines taken with the theodolite will here be of great service, as the base lines of a number of interior angles.

The surveyor having thus on paper, a representation of the estate, must draw such measuring lines on it, as will enable him to calculate the content of each field separately. Having made out a fair plot of his work, another line must be drawn for the true meridian, to the eastward of the former, according to the variation of the magnetic needle, where the estate lies. On this true meridian line may be placed any device whatever, as a north point. A title must also be given to the map, a scale drawn of the proportion used in the plotting, and a border to the whole *.

* See Crocker's Elements, p. 240.

Having thus explained the general practice of surveying according to the latest improvements, we shall shew how a surveyor is to proceed in measuring and planning counties and towns.

11 Method of surveying counties or districts.

To survey a County or large Tract of Land.—1. Chuse two, three, or four eminent places for stations, such as the tops of high hills or mountains, towers, or church steeples, which may be seen from one another, and from which most of the towns, and other places of note, may also be seen. And let them be as far distant from each other as possible. On these places raise beacons, or long poles, with flags of different colours flying at them, so as to be visible from all the other stations.

2. At all the places which are to be set down in the map, plant long poles with flags at them of several colours, to distinguish the places from each other, fixing them on the tops of church steeples, or the tops of houses, or in the centres of smaller towns.

It is not necessary to have these marks at many places at once, as suppose ten at a time. For when the angles have been taken at the two stations, to all these places, the marks may be removed to new ones, and so successively to all the places required. These marks being set up at a convenient number of places, and such as may be seen from both stations, go to one of these stations, and with an instrument for taking angles, standing at that station, take all the angles between the other station, and each of these marks, observing which is blue, which red, &c. and on which hand they lie; and set all down with their colours. Next go to the other station, and take all the angles between the first station, and each of the former marks, and set them down with the rest, each against those corresponding with the same colour. If practicable, the angles may also be taken at some third station, which may serve to prove the work, if the three lines intersect in that point where any mark stands. The marks must be allowed to remain till the observations are finished at both stations, and then they must be taken down, and set up at fresh places. The same operations must be performed at both stations, for these fresh places, and the like for others. The instrument for taking angles must be exceedingly accurate, made on purpose with telescopic sights,

SURVEYING.

PLATE DXXV.

Fig. 1.

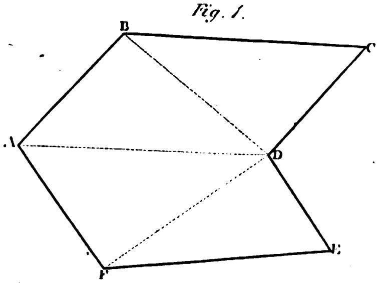


Fig. 2.

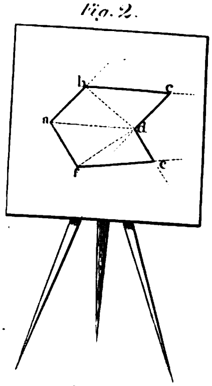


Fig. 4.

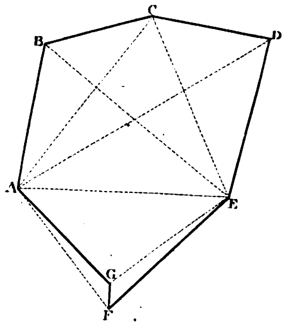


Fig. 5.

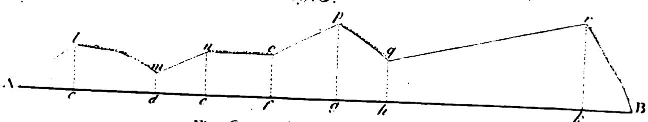


Fig. 3.

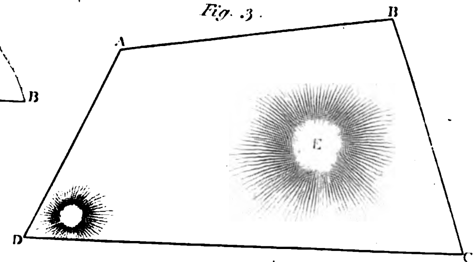


Fig. 6.

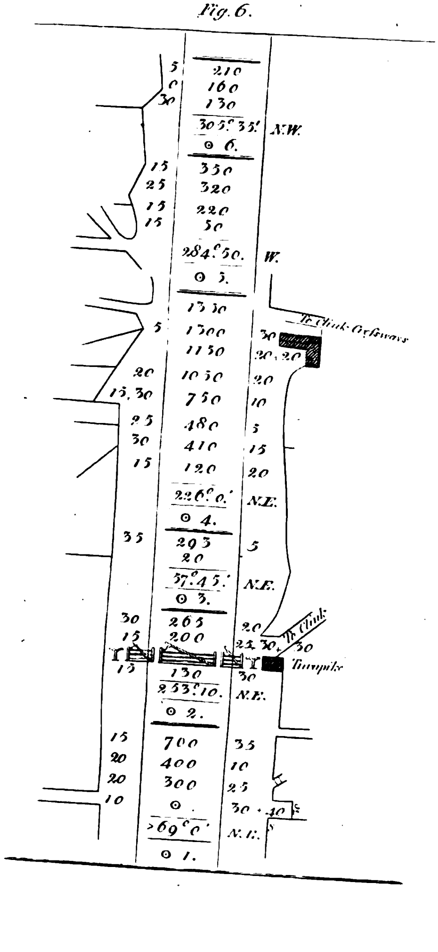


Fig. 7.

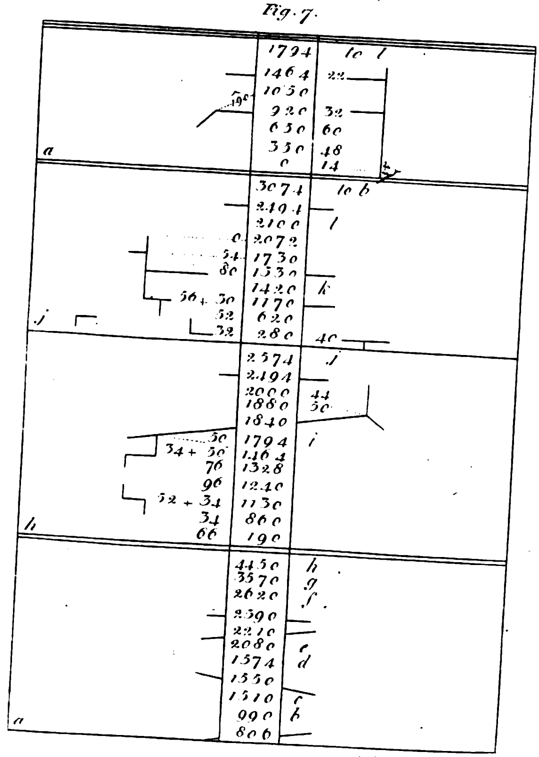


Fig. 8.

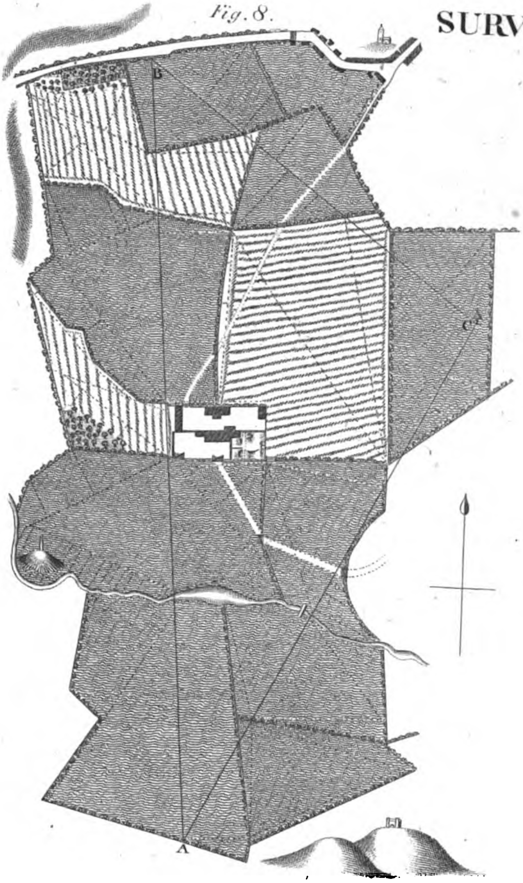


Fig. 9.

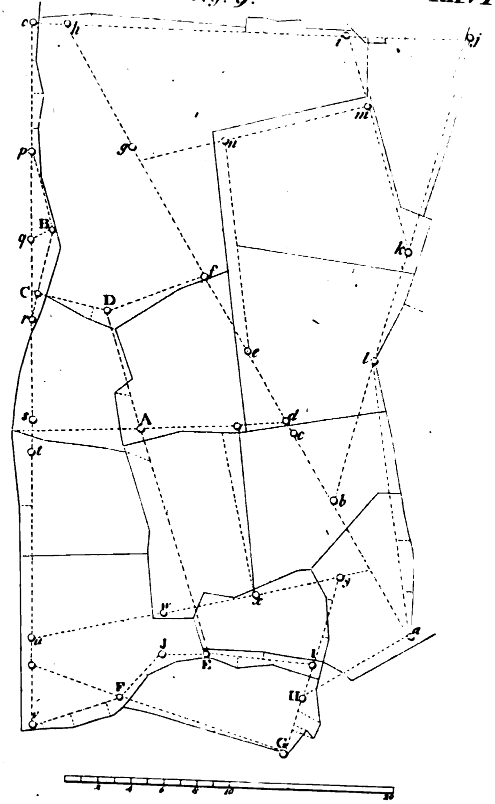
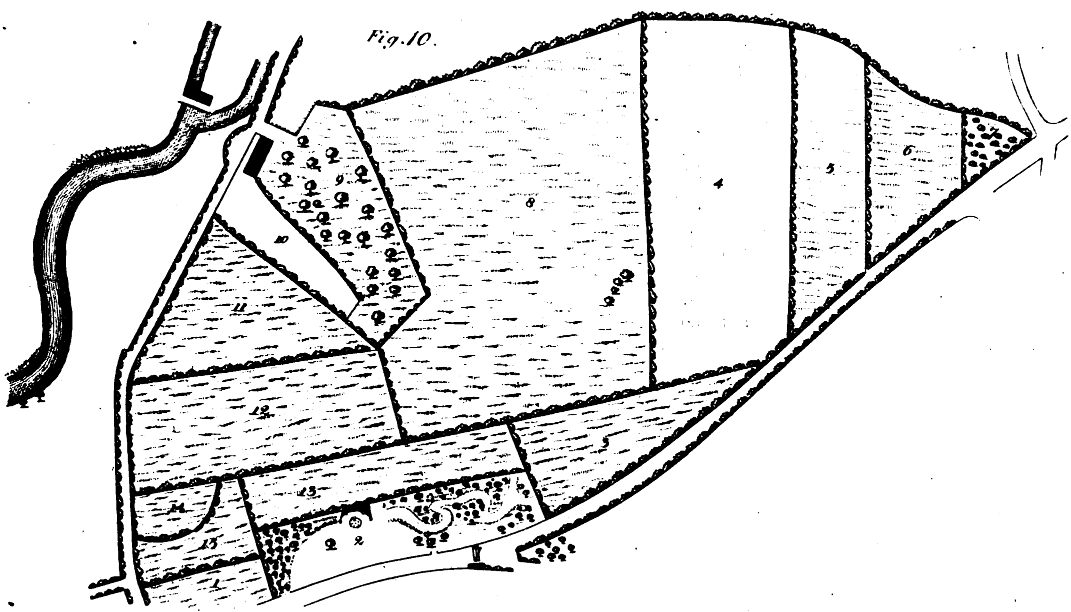


Fig. 10.



W. Archibald sculp.

SURVEYING.

PLATE DXXVII.

Fig. 11.

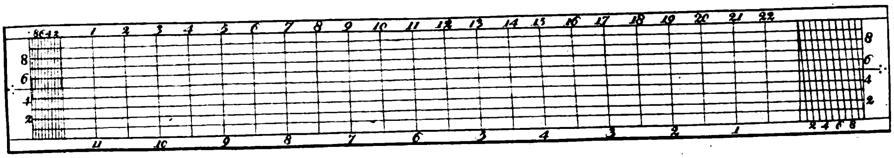


Fig. 12.

Fig. 13.

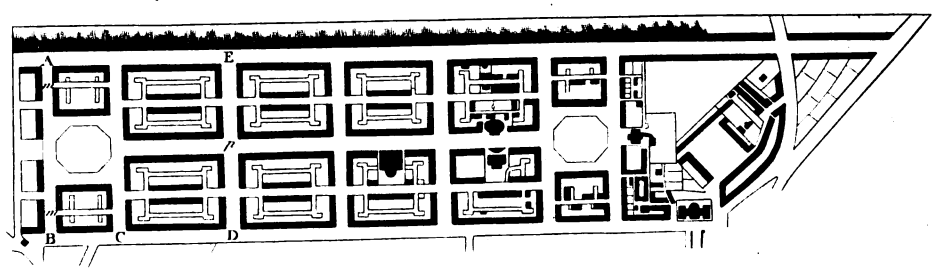


Fig. 14.

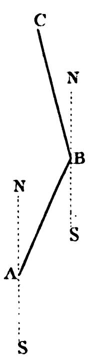


Fig. 15.

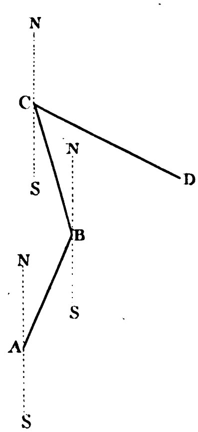


Fig. 16.

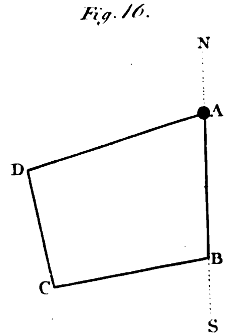


Fig. 17.

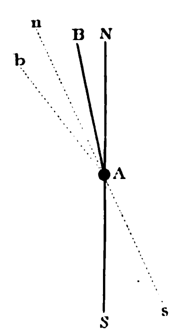
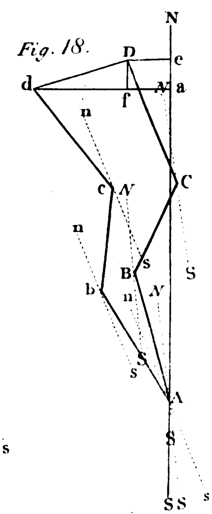


Fig. 18.



W. Archibald sculpt.

Surveying. sights, and of three, four, or five feet radius. A circumferentor is reckoned a good instrument for this purpose.

3. Though it be not absolutely necessary to measure any distance; because a stationary line being laid down from any scale, all the other lines will be proportional to it; yet it is better to measure some of the lines, to ascertain the distances of places in miles: and to know how many geometrical miles there are in any length; and from thence to make a scale for measuring any distance in miles. In measuring any distance, it will not be exact enough to go along the high roads, on account of their turnings and windings, and scarcely ever lying in a right line between the stations, which would cause endless reductions, and create trouble to make it a right line, for which reason it can never be exact. But a better way is to measure in a right line with a chain, between station and station, over hills and dales, or level fields, and all obstacles. Only in cases of water, woods, towns, rocks, banks, &c. where one cannot pass, such parts of the line must be measured by the method of inaccessible distances; and besides, allowing for ascents and descents, when we meet with them. A good compass that shews the bearing of two stations, will always direct to go straight, when the two stations are not seen; but when a straight progress can be made, offsets may be taken to any remarkable places, likewise noting the intersection of the stationary line, with all roads, rivers, &c.

4. From all the stations, and in the whole progress, care must be taken to observe sea coasts, the mouths of rivers, towns, castles, houses, churches, windmills, watermills, trees, rocks, sands, roads, bridges, fords, ferries, woods, hills, mountains, rills, brooks, parks, beacons, sluices, floodgates, locks, &c. and in general every thing remarkable.

5. When the first and main station lines are done, which command the whole country, inner stations are then to be taken at some places already determined, which will divide the whole into several partitions, and from these stations may be determined the places of as many of the remaining towns as possible. If any remain in that part, more stations may be taken at some places already determined, from which the rest may be determined. Proceeding thus through all parts of the country, station may be taken after station, till all that are required be determined. In general, the station distances must always pass through such remarkable points as have been formerly determined by the preceding stations.

6. The position of the station line measured, or the point of the compass on which it lies, must be determined by astronomical observation. Hang up a thread and plummet in the sun over some part in the station line, observing when the shadow runs along that line, and at that moment take the sun's altitude; then having his declination, and the latitude, the azimuth will be found by spherical trigonometry. The azimuth is the angle which the station line makes with the meridian, and therefore a meridian may easily be drawn through the map; or a meridian may be drawn through it by hanging up two threads in a line with the pole star, when due north, which may be known from astronomical tables. Or thus: Observe the star Alioth, or that in the rump of the Great Bear, being that next the square; or else Cassiopeia's hip; observing by a line and plummet when either of these stars and the pole star comes into a perpendicular; and at that time they are due north. Therefore two perpendicular lines being fixed at that moment, towards these two stars, will give the position of the meridian.

13 Method of surveying towns.

A Town or City may be surveyed with any of the instruments for taking angles, but best of all with the plane table, where every minute part is drawn while in sight. It is also proper to have a chain of 50 feet long, divided into 50 links, and an offset-staff of 10 feet long.

Begin at the meeting of two or more of the principal streets through which the longest prospect may be had, to get the longest station lines. Having there fixed the instrument, draw lines of direction along those streets, using two men as marks, or poles set in wooden pedestals, or perhaps some remarkable places in the houses at the farther ends, as windows, doors, corners, &c. Measure these lines with the chain, taking offsets with the staff, at all corners of streets, bendings, or windings, and to all remarkable objects, as churches, markets, halls, colleges, eminent houses, &c. Then remove the instrument to another station along one of these lines, and there repeat the same process as before, and so on till the whole be completed.

Thus, in fig. 13. (part of the New Town of Edinburgh) fix the instrument at A, and draw lines in the direction of all the streets meeting in that place, and measure AB, noting the street on the left at *m*. At the second station B, draw the directions of the streets meeting there, and measure CD. Do the same at D, and measure DE, noting the place at the cross streets at *p*. In this manner go through all the principal streets. This being done, proceed to the smaller and intermediate streets; and lastly to the lanes, alleys, courts, yards, and every part which it may be deemed expedient to represent *.

* See *Hutton's Math. Dict.* art. *Surveying.*

14 Subterraneous surveying.

We shall conclude this article with a few practical remarks on *subterraneous surveying*, or the method of surveying mines, and other works below ground, taken chiefly from Mr Fenwick's work on *subterraneous surveying*, lately published.

The instruments employed in surveying under ground, are the circumferentor, the chain (in coal mines) containing 100 links, and an instrument for taking the angles of elevation or depression, to reduce the measurements to horizontal distances, where the lines are not level. In lead mines, they sometimes employ a cord, divided into 10 feet, instead of a chain.

In conducting a subterraneous survey, the instrument used is placed where the survey is intended to commence, and a person goes forward in the direction of the line to be surveyed, holding a lighted candle in his hand, to the remotest point at which his light can be seen through the sights of the instrument; its bearing is then taken by the circumferentor, and noted down in the survey book. The surveyor then proceeds to take the distance of the light, or object, from the instrument, which is afterwards removed, and a person stands on the spot where it stood, holding one end of the chain in his hand, while another, going towards the object, holds the other end, together with a lighted candle, in the same hand, and being directed by the former, till the hand holding the candle

	C.	Northing. C. L.	Southing. C. L.	Easting. C. L.	Westing. C. L.
N. 32° W.	8	6 78			4 23
N. 7° E.	7	6 94		0 85	
N. 44° W.	8	5 75			5 55
		19 47	A *a*		9 78
					0 85
					8 93 *ad*.

	C.	C. L.	C. L.	C. L.	C. L.
N. 14° W.	8	7 76			1 93
N. 25° E.	7	6 34		2 95	
N. 26° W.	8	7 19			3 50
		21 29	A *e*		5 43
					2 95
					2 48 *e* D or *af*.

a d 8 chains 93 links—*a f* 2 chains 48 links=*f d* 6 chains 45 links.

A *e* 21 chains 29 links—A *a* 19 chains 47 links=*a e* or *f* D 1 chains 82 links.

Then, as *f d* 6.45	.8095595
Is to radius	10.0000000
So is *f* D 1.82	.2600714
To tang, $\angle d$ 15° 45′	9.4505117

From 90°—15° 45′=74° 15′, $\angle$ N *d* D.

And $\sqrt{\overline{6.45}^2+\overline{1.82}^2}=6.7$ *d*D, or 6 chains 70 links.

Ib. p. 155. Therefore, the amount of the error, or the bearing and distance of D from *d*, will be north, 74° 15′ east 6 chains 70 links with the true meridian.

SURVEYOR, a person who has the oversight and care of considerable works, lands, or the like.

Surveyor, likewise denotes a gauger; as also a person who surveys lands, and makes maps of them.

SURVIVOR, in *Law*, signifies the longest liver of joint tenants, or of any two persons jointly interested in a thing.

SURVIVORSHIP, is that branch of mathematics which treats of reversions payable provided one or more particular persons survive certain others. By reversions are meant payments not to take place till some future period. Survivorship forms one of the most difficult and complicated parts of the doctrine of reversions and life-annuities. It has been very fully treated of by Mr Thomas Simpson in his Select Exercises, and considerably improved by Dr Price and Mr Morgan, who have bestowed a great deal of attention on this subject; though some parts of their principles are erroneous.

The calculations are founded on the expectation of lives at different ages, deduced from tables formed from bills of mortality, of which see several examples under the article *Bills of Mortality*. By the expectation of life is meant the mean time that any single or joint lives at a given age is found to continue; that is, the number of years which, taking one with another, they actually enjoy, and may be considered as sure of enjoying; those who survive that period enjoying as much more time in proportion to their number as those who fall short of it enjoy less. Thus, supposing 46 persons alive all 40 years of age, and that one will die every year till they are all dead in 46 years, half 46 or 23 will be the *expectation* of each of them. If M. de Moivre's hypothesis were true, that men always decrease in an arithmetical progression, the expectation of a single life is always half its complement (A), and the expectation of two joint lives one-third of their common complement. Thus, supposing a man 40, his expectation would be 23, the half of 46, his complement; the expectation of two joint lives, each 40, would be 15 years 4 months, or the third part of 46.

The number expressing the expectation, multiplied by the number of single or joint lives (of which it is the expectation), added annually to a society, gives the whole number living together, to which such an annual addition would in time grow. Thus, since 19, or the third of 57, is the expectation of two joint lives, whose common age is 29, twenty marriages every year between persons of this age would in 57 years grow to 20 times 19,

(A) By the complement of a life is meant what it wants of 86, which M. de Moivre makes the boundary of human life. Thus if a man be 30, the complement of his life is 56.

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19, or 380 marriages, always existing together. And since the expectation of a single life is always half its complement, in 57 years 20 single persons added annually to a town will increase to 20 times 28.5, or 570; and when arrived at this number, the deaths every year will just equal the accessions, and no farther increase be possible. It appears from hence, that the particular proportion that becomes extinct every year, out of the whole number constantly existing together of single or joint lives, must, wherever this number undergoes no variation, be exactly the same with the expectation of those lives, at the time when their existence commenced. Thus, was it found that a 19th part of all the marriages among any bodies of men, whose numbers do not vary, are dissolved every year by the deaths of either the husband or wife, it would appear that 19 was, at the time they were contracted, the expectation of these marriages. In like manner, was it found in a society, limited to a fixed number of members, that a 28th part dies annually out of the whole number of members, it would appear that 28 was their common expectation of life at the time they entered. So likewise, were it found in any town or district, where the number of births and burials are equal, that a 20th or 30th part of the inhabitants die annually, it would appear that 20 or 30 was the expectation of a child just born in that town or district. These expectations, therefore, for all single lives, are easily found by a table of observations, showing the number that die annually at all ages out of a given number alive at those ages; and the general rule for this purpose is, to divide the sum of all the living in the table, at the age whose expectation is required, and at all greater ages, by the sum of all that die annually at that age and above it; or, which is the same, by the number (in the Table) of the living at that age; and half unity subtracted from the quotient will be the required expectation. Thus, in Dr Halley's table, given in the article ANNUITY, the sum of all the living at 20 and upwards is 20,724, which, divided by 598, the number living at the age of 20, and half unity subtracted from the quotient, gives 34.15 for the expectation of 20.

In calculating the value or expectation of joint lives, M. de Moivre had recourse to the hypothesis, that the probabilities of life decrease in a geometrical progression; believing that the values of joint lives, obtained by rules derived from it, would not deviate much from the truth. But in this he was greatly mistaken; they generally give results which are near a quarter of the true value too great in finding the present value of one life after it has survived another in a single payment, and about two-fifths too great when the value is sought in annual payments during the joint lives. They ought therefore to be calculated on the hypothesis (if they are calculated on hypothesis at all), that the probabilities of life decrease in arithmetical progression, which is not very far from the truth. Even this hypothesis never corresponds with the fact in the first and last periods of life, and in some situations not in any period of life. Dr Price and Mr Morgan therefore have given tables of the value of lives, not founded on any hypothesis, but deduced from bills of mortality themselves. Some of these we shall give at the end of this article. Mr Morgan has likewise given rules for calculating values of lives in this manner.

M. de Moivre has also fallen into mistakes in his rules for calculating the value of reversions depending on survivorship: these have been pointed out by Dr Price in the third essay in the first volume of his Treatise on Reversionary Payments; who has also given proper rules for calculating these values, the most important of which are comprehended in the following paragraphs.

1 Method of finding the number of annuitants that will come on a society.

Suppose a set of married men to enter into a society in order to provide annuities for their widows, and that it is limited to a certain number of members, and constantly kept up to that number by the admission of new members as the old ones are lost; it is of importance, in the first place, to know the number of annuitants that after some time will come upon the establishment. Now, since every marriage produces either a widow or widower; and since all marriages taken together would produce as many widows as widowers, were every man and his wife of the same age, and the chance equal which shall die first; it is evident, that the number of widows that have ever existed in the world, would in this case be equal to half the number of marriages. And what would take place in the world must also, on the same suppositions, take place in this society. In other words, every other person in such a society leaving a widow, there must arise from it a number of widows equal to half its own number. But this does not determine what number, all living at one and the same time, the society may expect will come to be constantly on it. It is, therefore, necessary to determine how long the duration of survivorship between persons of equal ages will be, compared with the duration of marriage. And the truth is, that, supposing the probabilities of life to decrease uniformly, the former is equal to the latter; and, consequently that the number of survivors, or (which is the same, supposing no second marriages) of widows and widowers alive together, which will arise from any given set of such marriages constantly kept up, will be equal to the whole number of marriages; or half of them (the number of widows in particular) equal to half the number of marriages. Now it appears that in most towns the decrease in the probabilities of life is in fact nearly uniform. According to the Breslaw Table of Observations (see ANNUITY), almost the same numbers die every year from 20 years of age to 77. After this, indeed, fewer die, and the rate of decrease in the probabilities of life is retarded. But this deviation from the hypothesis is inconsiderable; and its effect, in the present case, is to render the duration of survivorship longer than it would otherwise be. According to the London Table of Observations, the numbers dying every year begin to grow less at 50 years of age; and from hence to extreme old age there is a constant retardation in the decrease of the probabilities of life. Upon the whole, therefore, it appears that, according to the Breslaw Table, and supposing no widows to marry, the number inquired after is somewhat greater than half the number of the society: but, according to the London Table, a good deal greater. This, however, has been determined on the supposition that the husbands and wives are of equal ages, and that then there is an equal chance who shall die first. But in reality husbands are generally older than wives, and males have been found to die sooner than females, as appears incontestably from several of the tables in Dr Price's Treatise on Reversions. It is therefore more than an equal chance that the husband will die before his wife. This will increase considerably the duration of

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of survivorship on the part of the women, and consequently the number which we have been inquiring after. The marriage of widows will diminish this number, but not so much as the other causes will increase it.

2 When the number of annuitants arrives at its maximum.

If the society comprehends in it from the first all the married people of all ages in any town, or among any class of people where the numbers always continue the same, the whole collective body of members will be at their greatest age at the time of the establishment of the society; and the number of widows left every year will at a medium be always the same. The number of widows will increase continually on the society, till as many die every year as are added. This will not be till the whole collective body of widows are at their greatest age, or till there are among them the greatest possible number of the oldest widows; and therefore not till there has been time for an accession to the oldest widows from the youngest part.

Let us, for the sake of greater precision, divide the whole medium of widows that come on every year into different classes according to their different ages, and suppose some to be left at 56 years of age, some at 46, some at 36, and some at 26. The widows, constantly in life together, derived from the first class, will come to their greatest age, and to a *maximum*, in 30 years, supposing, with M. de Moivre, 86 to be the utmost extent of life. The same will happen to the second class in 40 years, and to the third in 50 years. But the whole body composed of these classes will not come to a *maximum* till the same happens to the fourth or youngest class; that is, not till the end of 60 years. After this the affairs of the society will become stationary, and the number of annuitants on it of all ages will keep always nearly the same.

If a society begins with its complete number of members, but at the same time admits none above a particular age: If, for instance, it begins with 200 members all under 50, and afterwards limits itself to this number, and keeps it up by admitting every year, at all ages between 26 and 50, new members as old ones drop off; in this case, the period necessary for bringing on the *maximum* of annuitants will be just doubled.

3 What a man ought to pay in a single payment to entitle his widow to a certain annuity.

To determine the sum that every individual ought to pay in a single present payment, in order to intitle his widow to a certain annuity for her life, let us suppose the annuity 3l. per annum, and the rate of interest four per cent. It is evident, that the value of such an expectation is different, according to the different ages of the purchasers, and the proportion of the age of the wife to that of the husband. Let us then suppose that every person in such a society is of the same age with his wife, and that one with another all the members when they enter may be reckoned 40 years of age, as many entering above this age as below it. It has been demonstrated by M. de Moivre and Mr Simpson, that the value of an annuity on the joint continuance of any two lives, subtracted from the value of an annuity on the life in expectation, gives the true present value of annuity on what may happen to remain of the latter of the two lives after the other.

In the present case, the value of an annuity to be enjoyed during the joint continuance of two lives, each 40, is, by Table II. 9.826, according to the probabilities of life in the Table of Observations formed by Dr Halley from the bills of mortality of Breslaw in Silesia.

The value of a single life 40 years of age, as given by M. de Moivre, agreeably to the same table, is 13.20; and the former subtracted from the latter, leaves 3.37, or the true number of years purchase, which ought to be paid for any given annuity, to be enjoyed by a person 40 years of age, provided he survives another person of the same age, interest being reckoned at four per cent. per annum. The annuity, therefore, being 30l. the present value of it is 30 multiplied by 3.37, or 101l. 2s.

4 What he ought to pay in annual payments.

If, instead of a single present payment, it is thought preferable to make annual payments during the marriage; what these annual payments ought to be is easily determined by finding what annual payments during two joint lives of given ages are equivalent to the value of the reversionary annuity in present money. Suppose, as before, that the joint lives are each 40, and the reversionary annuity 30l. per annum. An annual payment during the continuance of two such lives is worth (according to Table II.) 9.82 years purchase. The annual payment ought to be such as, being multiplied by 9.82, will produce 101.1l. the present value of the annuity in one payment. Divide then 101.1 by 9.82, and 10.3 the quotient will be the annual payment. This method of calculation supposes that the first annual payment is not to be made till the end of a year. If it is to be made immediately, the value of the joint lives will be increased one year's purchase; and therefore, in order to find the annual payments required, the value of a present single payment must be divided by the value of the joint lives increased by unity. If the society prefer paying part of the value in a present single payment on admission, and the rest in annual payments; and if they fix these annual payments at a particular sum, the present single payment paid on admission is found by subtracting the value of the annual payment during the joint lives from the whole present value of the annuity in one payment. Suppose, for instance, the annual payments to be fixed at five guineas, the annuity to be 30l. the rate of interest four per cent. and the joint lives each 40; the value of the annuity in one present single payment is 101.1l. The value of five guineas or 5.25 per annum, is (5.25 multiplied by 9.82 the value of the joint lives) 51.55; which, subtracted from 101.1l. gives 49.5l. the answer.

If a society takes in all the marriages among persons of a particular profession within a given district, and subjects them for perpetuity to a certain equal and common tax or annual payment, in order to provide life annuities for all the widows that shall result from these marriages; since, at the commencement of such an establishment, all the oldest, as well as the youngest, marriages are to be intitled equally to the proposed benefit, a much greater number of annuitants will come immediately on it than would come on any similar establishment which limited itself in the admission of members to persons not exceeding a given age. This will check that accumulation of money which should take place at first, in order to produce an income equal to the disbursements at the time when the number of annuitants comes to a *maximum*; and therefore will be a particular burden upon the establishment in its infancy. For this some compensation must be provided; and the equitable method of providing it is, by levying fines at the beginning of the establishment on every member exceeding

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ceeding a given age, proportioned to the number of years which he has lived beyond that age. But if such fines cannot be levied, and if every payment must be equal and common, whatever disparity there may be in the value of the expectations of different members, the fines must be reduced to one common one, answering as nearly as possible to the disadvantage, and payable by every member at the time when the establishment begins. After this, the establishment will be the same with one that takes upon it all at the time they marry; and the tax or annual payment of every member adequate to its support will be the annual payment during marriage due from persons who marry at the mean age at which, upon an average, all marriages may be considered as commencing. The fines to be paid at first are, for every particular member, the same with the difference between the value of the expectation to him at his present age, and what would have been its value to him had the scheme begun at the time he married. Or, they are, for the whole body of members, the difference between the value of the common expectation, to persons at the mean age of all married persons taken together as they exist in the world, and to persons at that age which is to be deemed their mean age when they marry.

5

Method of finding the present value of an annuity to be enjoyed by one life after the expiration of another.

Suppose we wish to know the present value of an annuity to be enjoyed by one life, for what may happen to remain of it beyond another life, after a given term; that is, provided both lives continue from the present time to the end of a given term of years; the method of calculating is this: Find the value of the annuity for two lives, greater by the given term of years than the given lives; discount this value for the given term; and then multiply by the probability, that the two given lives shall both continue the given term; and the product will be the answer. Thus, let the two lives be each 30, the term seven years, the annuity 10l. interest four per cent. The given lives, increased by seven years, become each 37. The value of two joint lives, each 37, is (by Table II.) 10.25. The value of a single life at 37 is (by the table under the article ANNUITY) 13.67. The former subtracted from the latter is 3.42, or the value of an annuity for the life of a person 37 years of age, after another of the same age, as has been shown above. 3.42 discounted for seven years (that is, multiplied by 0.76 the value of 1l. due at the end of seven years) is 2.6. The probability that a single life at 30 shall continue seven years is $\frac{49}{56}$ (B). The probability, therefore, that two such lives shall continue seven years, is $\frac{2401}{3136}$, or in decimals 0.765; and 2.6 multiplied by 0.765 is 1.989, the number of years purchase which ought to be given for an annuity to be enjoyed by a life now 30 years of age, after a life of the same age, provided both continue seven years. The annuity then being 10l. its present value is 19.89l.

6

Method of finding the value of an annuity for what may happen to remain of one life after another, provided the life in expectation continues a given time.

Suppose the value is required of an annuity to be enjoyed for what may happen to remain of one life after another, provided the life in expectation continues a given time. 1. Find the present value of the annuity for the remainder of the life in expectation after the given time, which is done in this manner: Multiply the present value of the life at the given time by the present value of 1l. to be received at that time, and multiply the product again by the probability that the life in expectation will continue so long. Let the given time which the life in expectation is to continue be 15 years, and let the person then be arrived at 50 years of age. A life at fifty, according to M. de Moivre's valuation of lives, and reckoning interest at four per cent. is worth 11.34 years purchase. The present value of 1l. to be received at the end of 15 years, is 0,5553, and the probability that a life at 35 will continue 15 years is $\frac{146}{490}$. These three values multiplied into one another give 4.44l. for the present value of the life in expectation. 2. Find the value of the reversion, provided both lives continue the given time, by the rule given in parag. 5th. 3. Add these values together, and the sum will be the answer in a single present payment. We shall now illustrate this rule by an example.

An annuity of 10l. for the life of a person now 30, is to commence at the end of 11 years, if another person now 40 should be then dead; or, if this should not happen at the end of any year beyond 11 years in which the former shall happen to survive the latter: What is the present value of such an annuity, reckoning interest at four per cent, and taking the probabilities of life as they are in Dr Halley's table, given in the article MORTALITY?

The value of 10l. per annum, for the remainder of the life of a person now 30, after 11 years is 69.43l. The probability that a person 40 years of age shall live 11 years, is, by Dr Halley's table $\frac{315}{445}$. The probability, therefore, that he will die in 11 years, is $\frac{315}{445}$ subtracted from unity (C), or $\frac{110}{445}$; which multiplied by 69.43l. gives 17.16l.—The value of the reversion, provided both live 11 years, is 17l. and this value added to the former, makes 34.16l. the value required in a single present payment; which payment divided by 11.43l. the value of two joint lives, aged 30 and 40, with unity added, gives 3l.; or the value required in annual payments during the joint lives, the first payment to be made immediately.

TABLE

(B) The probability that a given life shall continue any number of years, or reach a given age, is (as is well known) the fraction, whose numerator is the number of the living in any table of observations opposite to the given age, and denominator, the number opposite to the present age of the given life.

(C) For the difference between unity and the fraction expressing the probability that an event will happen, gives the probability that it will not happen.

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Table I. *Showing the Present Values of an Annuity of* 1l. *on a Single Life, according to M. de Moivre's Hypothesis.*

Age.	3 per ct.	3½ perct.	4 per ct.	4½ perct.	5 per ct.	6 per ct.
8	19.736	18.160	16.791	15.595	14.544	12.790
9	19.868	18.269	16.882	15.672	14.607	12.839
10	19.868	18.269	16.882	15.672	14.607	12.839
11	19.736	18.160	16.791	15.595	14.544	12.790
12	19.604	18.049	16.698	15.517	14.480	12.741
13	19.469	17.937	16.604	15.437	14.412	12.691
14	19.331	17.823	16.508	15.356	14.342	12.639
15	19.192	17.707	16.410	15.273	14.271	12.586
16	19.050	17.588	16.311	15.189	14.197	12.532
17	18.905	17.467	16.209	15.102	14.123	12.476
18	18.759	17.344	16.105	15.015	14.047	12.419
19	18.610	17.220	15.999	14.923	13.970	12.361
20	18.458	17.093	15.891	14.831	13.891	12.301
21	18.305	16.963	15.781	14.737	13.810	12.239
22	18.148	16.830	15.669	14.641	13.727	12.177
23	17.990	16.696	15.554	14.543	13.642	12.112
24	17.827	16.559	15.437	14.442	13.555	12.045
25	17.664	16.419	15.318	14.340	13.466	11.978
26	17.497	16.277	15.197	14.235	13.375	11.908
27	17.327	16.133	15.073	14.128	13.282	11.837
28	17.154	15.985	14.946	14.018	13.186	11.763
29	16.979	15.835	14.816	13.905	13.088	11.688
30	16.800	15.682	14.684	13.791	12.988	11.610
31	16.620	15.526	14.549	13.673	12.855	11.530
32	16.436	15.367	14.411	13.553	12.780	11.449
33	16.248	15.204	14.270	13.430	12.673	11.365
34	16.057	15.039	14.126	13.304	12.562	11.278
35	15.864	14.871	13.979	13.175	12.449	11.189
36	15.666	14.699	13.829	13.044	12.333	11.098
37	15.465	14.524	13.676	12.909	12.214	11.003
38	15.260	14.345	13.519	12.771	12.091	10.907
39	15.053	14.163	13.359	12.630	11.966	10.807
40	15.842	13.978	13.196	12.485	11.837	10.704
41	14.626	13.789	13.028	12.337	11.705	10.599
42	14.407	13.596	12.858	12.185	11.570	10.490
43	14.185	13.399	12.683	12.029	11.431	10.378
44	13.958	13.199	12.504	11.870	11.288	10.263
45	13.728	12.993	12.322	11.707	11.142	10.144
46	13.493	12.784	12.135	11.540	10.992	10.021
47	13.254	12.571	11.944	11.368	10.837	9.895
48	13.012	12.354	11.748	11.192	10.679	9.765
49	12.764	12.131	11.548	11.012	10.515	9.630
50	12.511	11.904	11.344	10.827	10.348	9.492
51	12.255	11.673	11.135	10.638	10.176	9.349
52	11.994	11.437	10.921	10.443	9.999	9.201
53	11.729	11.195	10.702	10.243	9.817	9.049
54	11.457	10.950	10.478	10.039	9.630	8.891
55	11.183	10.698	10.248	9.829	9.437	8.729
56	10.902	10.443	10.014	9.614	9.239	8.561
57	10.616	10.181	9.773	9.393	9.036	8.387
58	10.325	9.913	9.527	9.166	8.826	8.208
59	10.029	9.640	9.275	8.933	8.611	8.023
60	9.727	9.361	9.017	8.694	8.389	7.831
61	9.419	9.076	8.753	8.449	8.161	7.633
62	9.107	9.786	8.482	8.197	7.926	7.428
63	8.787	8.488	8.205	7.938	7.684	7.216
64	8.462	8.185	7.921	7.672	7.435	6.997
65	8.132	7.875	7.631	7.399	7.179	6.770
66	7.794	7.558	7.333	7.119	6.915	6.535
67	7.450	7.234	7.027	6.831	6.643	6.292
68	7.099	6.902	6.714	6.534	6.362	6.040
69	6.743	6.565	6.394	6.230	6.073	5.779
70	6.378	6.219	6.065	5.918	5.775	5.508
71	6.008	5.865	5.728	5.596	5.468	5.228
72	5.631	5.505	5.383	5.265	5.152	4.937
73	5.246	5.136	5.029	4.926	4.826	4.636
74	4.854	4.759	4.666	4.576	4.489	4.324
75	4.453	4.373	4.293	4.217	4.143	4.000
76	4.046	3.978	3.912	3.847	3.784	3.664
77	3.632	3.575	3.520	3.467	3.415	3.315
78	3.207	3.163	3.111	3.076	3.034	2.953
79	2.776	2.741	2.707	2.673	2.641	2.578
80	2.334	2.309	2.284	2.259	2.235	2.188
81	1.886	1.867	1.850	1.832	1.816	1.783
82	1.429	1.411	1.406	1.394	1.384	1.362
83	0.961	0.955	0.950	0.943	0.937	0.925
84	0.484	0.483	0.481	0.479	0.479	0.472
85	0.000	0.000	0.000	0.000	0.000	0.000

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Table II. *Showing the Value of an Annuity on the Joint Continuance of Two Lives, according to M. de Moivre's Hypothesis.*

Age of the Youngest.	Age of the Eldest.	Value at 5 per cent.	Value at 3 per cent	Value at 4 per cent.
10	10	15.209	13.342	11.855
	15	14.878	13.093	11.661
	20	14.503	12.808	11.430
	25	14.074	12.480	11.182
	30	13.585	12.102	10.884
	35	13.025	11.665	10.537
	40	12.381	11.156	10.128
	45	11.644	10.564	9.646
	50	10.796	9.871	9.074
	55	9.822	9.059	8.391
	60	8.704	8.105	7.572
	65	7.417	6.980	6.585
	70	5.936	5.652	5.391
15	15	14.574	12.860	11.478
	20	14.225	12.593	11.266
	25	13.822	12.281	11.022
	30	13.359	11.921	10.736
	35	12.824	11.501	10.403
	40	12.207	11.013	10.008
	45	11.496	10.440	9.541
	50	10.675	9.767	8.985
	55	9.727	8.975	8.318
	60	8.632	8.041	7.515
	65	7.377	6.934	6.544
	70	5.932	5.623	5.364
20	20	13.904	12.341	11.067
	25	13.531	12.051	10.840
	30	13.098	11.711	10.565
	35	12.594	11.314	10.278
	40	12.008	10.847	9.870
	45	11.325	10.297	9.420
	50	10.536	9.648	8.880

Age

Age of the Youngest.	Age of the Eldest.	Value at 3 per cent.	Value at 4 per cent.	Value at 5 per cent.
	55	9.617	8.879	8.233
	60	8.549	7.967	7.448
	65	7.308	6.882	6.495
	70	5.868	5.590	5.333
25	25	13.192	11.786	10.621
	30	12.794	11.468	10.367
	35	12.333	11.093	10.067
	40	11.770	10.655	9.708
	45	11.130	10.131	9.278
	50	10.374	9.509	8.761
	55	9.488	8.766	8.134
	60	8.452	7.880	7.371
	65	7.241	6.826	6.440
	70	5.826	5.551	5.294
30	30	12.434	11.182	10.133
	35	12.010	10.838	9.854
	40	11.502	10.428	9.514
	45	10.898	9.936	9.112
	50	10.183	9.345	8.620
	55	9.338	8.634	8.018
	60	8.338	7.779	7.280
	65	7.161	6.748	6.373
	70	5.777	5.505	5.254
35	35	11.632	10.530	9.600
	40	11.175	10.157	9.291
	45	10.622	9.702	8.913
	50	9.955	9.149	8.450
	55	9.156	8.476	7.879
	60	8.202	7.658	7.172
	65	7.066	6.662	6.294
	70	5.718	5.450	5.203
40	40	10.777	9.826	9.014
	45	10.283	9.418	8.671
	50	9.677	8.911	8.244
	55	8.936	8.283	7.710
	60	8.038	7.510	7.039
	65	6.951	6.556	6.198
	70	5.646	5.383	5.141
45	45	9.863	9.063	8.370
	50	9.331	8.619	7.987
	55	8.662	8.044	7.500
	60	7.831	7.332	6.875
	65	6.807	6.435	6.080
	70	5.556	5.300	5.063
50	50	8.892	8.235	7.660
	55	8.312	7.738	7.230
	60	7.568	7.091	6.664
	65	6.623	6.258	5.926
	70	5.442	5.193	4.964
55	55	7.849	7.332	6.873
	60	7.220	6.781	6.386
	65	6.379	6.036	5.724
	70	5.201	5.053	4.833
60	60	6.737	6.351	6.001
	65	6.043	5.730	5.444
	70	5.081	4.858	4.653
65	65	5.547	5.277	5.031
	70	4.773	4.571	4.385
70	70	4.270	4.104	3.952

Table II. *Showing the Values of Annuities on Single Lives, among Males and Females, according to the Probabilities of the Duration of Life in the kingdom of Sweden.*

	Males.		Females.		Lives in general.	
Ages.	4 per ct.	5 per ct.	4 per ct.	5 per ct.	4 per ct.	5 per ct.
1	16.503	14.051	16.820	14.271	16.661	14.161
2	17.355	14.778	17.719	15.034	17.537	14.906
3	17.935	15.279	18.344	15.571	18.139	15.425
4	18.328	15.624	18.780	15.951	18.554	15.787
5	18.503	15.786	18.927	16.088	18.715	15.937
6	18.622	15.901	19.045	16.203	18.833	16.052
7	18.693	15.977	19.131	16.291	18.912	16.134
8	18.725	16.021	19.162	16.335	18.943	16.178
9	18.715	16.030	19.151	16.343	18.933	16.186
10	18.674	16.014	19.109	16.325	18.891	16.169
11	18.600	15.970	19.041	16.286	18.820	16.128
12	18.491	15.896	18.952	16.229	18.721	16.062
13	18.378	15.819	18.840	16.153	18.609	15.986
14	18.246	15.724	18.707	16.059	18.476	15.891
15	18.105	15.624	18.568	15.960	18.336	15.792
16	17.958	15.517	18.424	15.856	18.191	15.686
17	17.803	15.404	18.290	15.761	18.046	15.582
18	17.643	15.285	18.151	15.662	17.897	15.473
19	17.492	15.175	18.013	15.563	17.752	15.369
20	17.335	15.059	17.872	15.462	17.603	15.260
21	17.192	14.955	17.725	15.356	17.458	15.155
22	17.042	14.846	17.573	15.24[illegible]	17.307	15.045
23	16.887	14.732	17.414	15.129	17.150	14.930
24	16.742	14.627	17.252	15.009	16.997	14.818
25	16.592	14.517	17.087	14.886	16.839	14.701
26	16.436	14.402	16.915	14.757	16.675	14.579
27	16.274	14.282	16.751	14.636	16.512	14.459
28	16.105	14.156	16.588	14.515	16.346	14.335
29	15.930	14.024	16.427	14.396	16.178	14.210
30	15.751	13.889	16.261	14.272	16.006	14.080
31	15.575	13.756	16.104	14.156	15.839	13.956
32	15.395	13.619	15.941	14.035	15.668	13.827
33	15.208	13.477	15.787	13.923	15.497	13.700
34	15.014	13.327	15.629	13.806	15.321	13.566
35	14.812	13.170	15.465	13.684	15.138	13.427
36	14.601	13.006	15.278	13.542	14.939	13.274
37	14.382	12.833	15.070	13.387	14.726	13.107
38	14.154	12.652	14.854	13.213	14.504	12.932
39	13.916	12.467	14.629	13.036	14.272	12.749
40	13.668	12.261	14.401	12.856	14.034	12.558
41	13.426	12.065	14.183	12.687	13.805	12.370
42	13.196	11.880	13.994	12.538	13.593	12.209
43	12.984	11.710	13.798	12.387	13.391	12.048
44	12.763	11.532	13.596	12.229	13.179	11.880
45	12.535	11.347	13.383	12.061	12.959	11.702
46	12.297	11.153	13.151	11.876	12.724	11.514
47	12.051	10.951	12.894	11.668	12.472	11.309
48	11.795	10.738	12.620	11.443	12.217	11.090
49	11.528	10.516	12.333	11.205	11.930	10.860
50	11.267	10.298	12.049	10.970	11.658	10.634
51	11.030	10.100	11.769	10.737	11.399	10.418
52	10.785	9.895	11.492	10.507	11.138	10.201
53	10.531	9.682	11.220	10.280	10.875	9.981
54	10.269	9.460	10.937	10.042	10.603	9.751
55	9.998	9.229	10.642	9.792	10.320	9.510

Survivorship.

Ages.	Males. 4 per ct.	Males. 5 per ct.	Females. 4 per ct.	Females. 5 per ct.	Lives in general. 4 per ct.	Lives in general. 5 per ct.
56	9.717	8.988	10.334	9.529	10.025	9.258
57	9.425	8.736	10.012	9.253	9.778	8.994
58	9.140	8.489	9.692	8.976	9.416	8.732
59	8.845	8.232	9.358	8.627	9.101	8.458
60	8.540	7.963	9.039	8.406	8.789	8.184
61	8.241	7.700	8.739	8.144	8.490	7.922
62	7.950	7.442	8.453	7.805	8.201	7.663
63	7.669	7.193	8.166	7.643	7.917	7.418
64	7.382	6.938	7.870	7.382	7.626	7.160
65	7.090	6.676	7.566	7.111	7.328	6.893
66	6.792	6.408	7.254	6.831	7.022	6.619
67	6.489	6.134	6.930	6.541	6.709	6.337
68	6.201	5.872	6.596	6.239	6.398	6.055
69	5.933	5.628	6.253	5.926	6.093	5.777
70	5.670	5.389	5.897	5.599	5.783	5.494
71	5.418	5.158	5.564	5.293	5.491	5.225
72	5.180	4.940	5.261	5.013	5.220	4.976
73	4.940	4.719	4.998	4.770	4.969	4.744
74	4.724	4.521	4.792	4.581	4.758	4.551
75	4.487	4.302	4.582	4.383	4.534	4.345
76	4.253	4.084	4.367	4.189	4.310	4.136
77	4.024	3.871	4.145	3.983	4.084	3.927
78	3.768	3.631	3.913	3.767	3.840	3.699
79	3.512	3.390	3.663	3.536	3.590	3.463
80	3.260	3.152	3.402	3.285	3.331	3.218
81	3.017	2.921	3.145	3.041	3.081	2.981
82	2.792	2.706	2.905	2.812	2.848	2.759
83	2.600	2.523	2.699	2.615	2.649	2.569
84	2.473	2.403	2.[illegible]59	2.482	2.516	2.441
85	2.371	2.306	2.552	2.476	2.461	2.391
86	2.281	2.222	2.518	2.446	2.399	2.334
87	2.154	2.103	2.431	2.365	2.292	2.338
88	1.955	1.912	2.294	2.236	2.124	2.074
89	1.698	1.664	2.108	2.059	1.903	1.861
90	1.417	1.392	1.873	1.833	1.645	1.612
91	1.154	1.136	1.628	1.596	1.391	1.366
92	0.835	0.824	1.349	1.325	1.092	1.074
93	0.477	0.471	1.071	1.054	0.774	0.762
94	0.240	0.238	0.799	0.788	0.519	0.513
95	0.000	0.000	0.544	0.537		
96	0.000	0.000	0.320	0.317		

TABLE IV. *Showing the Value of Annuities on Two Joint Lives, according to the Probabilities of the Duration of Human Life, among Males and Females collectively, reckoning interest at 4 per cent.*

Interest 4 per cent.

Difference of 0, 6, 12, and 18 years.

Ages.	Values	Ages.	Values	Ages.	Values.	Ages.	Values.
1- 1	12.252	1- 7	13.989	1-13	13.894	1-19	13.389
2- 2	13.583	2- 8	14.780	2-14	14.557	2-20	14.008
3- 3	14.558	3- 9	15.323	3-15	14.988	3-21	14.417
4- 4	15.267	4-10	15.685	4-16	15.259	4-22	14.671
5- 5	15.577	5-11	15.817	5-17	15.326	5-23	14.725
6- 6	15.822	6-12	15.887	6-18	15.324	6-24	14.740

Survivorship.

Interest 4 per cent.

Ages.	Values.	Ages	Values	Ages.	Values	Ages.	Values
7- 7	16.003	7-13	15.914	7-19	15.351	7-25	14.727
8- 8	16.109	8-14	15.888	8-20	15.310	8-26	14.673
9- 9	16.152	9-15	15.824	9-21	15.244	9-27	14.590
10-10	16.141	10-16	15.729	10-22	15.149	10-28	14.484
11-11	16.087	11-17	15.6[illegible]7	11-23	15.033	11-29	14.357
12-12	15.982	12-18	15.477	12-24	14.889	12-30	14.202
13-13	15.855	13-19	15.327	13-25	14.736	13-31	14.045
14-14	15.70[illegible]	14-20	15.[illegible]64	14-26	14.565	14-32	13.874
15-15	15.535	15-21	15.00[illegible]	15-27	14.392	15-33	13.700
16-16	15.361	16-22	14.832	16-28	14.216	16-34	13.520
17-17	15.196	17-23	14.665	17-29	14.042	17-35	13.340
18-18	15.023	18-24	14.491	18-30	13.860	18-36	13.141
19-19	14.854	19-25	14.320	19-31	13.687	19-37	13.934
20-20	14.682	20-26	14.144	20-32	13.51[illegible]	20-38	12.720
21-21	14.525	21-27	13.976	21-33	13.345	21-39	12.505
22-22	14.360	22-28	13.807	22-34	13.173	22-40	12.236
23-23	14.194	23-29	13.635	23-35	12.997	23-41	12.073
24-24	14.020	24-30	13.455	24-36	12.801	24-42	11.873
25-25	13.849	25-31	13.284	25-37	12.509	25-43	11.683
26-26	13.671	26-32	13.[illegible]08	26-38	12.387	26-44	11.485
27-27	13.495	27-33	12.935	27-39	12.170	27-45	11.234
28-28	13.323	28-34	12.763	28-40	11.953	28-46	11.072
29-29	13.148	29-35	12.586	29-41	11.742	29-47	10.847
30-30	12.965	30-36	12.390	30-42	11.547	30-48	10.606
31-31	12.795	31-37	12.192	31-43	11.359	31-49	10.365
32-32	12.624	32-38	11.988	32-44	11.170	32-50	10.128
33-33	12.456	33-39	11.779	33-45	10.978	33-51	9.905
34-34	12.286	34-40	11.568	34-46	10.775	34-52	9.679
35-35	12.109	35-41	11.361	35-47	10.557	35-53	9.452
36-36	11.904	36-42	11.156	36-48	10.314	36-54	9.207
37-37	11.683	37-43	10.953	37-49	10.059	37-55	8.951
38-38	11.452	38-44	10.741	38-50	9.805	38-56	8.685
39-39	11.209	39-45	10.519	39-51	9.558	39-57	8.404
40-40	10.964	40-46	10.286	40-52	9.308	40-58	8.124
41-41	10.732	41-47	10.049	41-53	9.060	41-59	7.839
42-42	10.531	42-48	9.813	42-54	8.837	42-60	7.569
43-43	10.346	43-49	9.581	43-55	8.597	43-61	7.318
44-44	10.154	44-50	9.351	44-56	8.354	44-62	7.075
45-45	9.954	45-51	9.129	45-57	8.101	45-63	6.836
46-46	9.736	46-52	8.897	46-58	7.841	46-64	6.586
47-47	9.497	47-53	8.658	47-59	7.563	47-65	6.323
48-48	9.236	48-54	8.402	48-60	7.281	48-66	6.048
49-49	8.966	49-55	8.139	49-61	7.008	49-67	5.764
50-50	8.707	50-56	7.874	50-62	6.749	50-68	5.487
51-51	8.469	51-57	7.613	51-63	6.505	51-69	5.221
52-52	8.232	52-58	7.351	52-64	6.256	52-70	4.953
53-53	7.993	53-59	7.083	53-65	6.002	53-71	4.694
54-54	7.748	54-60	6.814	54-66	5.743	54-72	4.455
55-55	7.493	55-61	6.555	55-67	5.474	55-73	4.231
56-56	7.229	56-62	6.299	56-68	5.204	56-74	4.043
57-57	6.924	57-63	6.045	57-69	4.936	57-75	3.844
58-58	6.678	58-64	5.788	58-70	4.66[illegible]	58-76	3.637
59-59	6.388	59-65	5.519	59-71	4.39[illegible]	59-77	3.430
60-60	6.104	60-66	5.249	60-72	4.149	60-78	3.210
61-61	5.844	61-67	4.984	61-73	3.927	61-79	2.974
62-62	5.600	62-68	4.729	62-74	3.747	62-80	2.744
63-63	5.367	63-69	4.482	63-75	3.563	63-81	2.557
64-64	5.128	64-70	4.231	64-76	3.370	64-82	2.396
65-65	4.881	65-71	3.982	65-77	3.180	65-83	2.252
66-66	4.626	66-72	3.750	66-78	2.974	66-84	2.123

Interest

Survivorship.

Interest 4 per cent.

Ages.	Values.	Ages.	Values.	Ages.	Values.	Ages.	Values.
67-67	4.362	67-73	3.527	67-79	2.743	67-85	2.010
68-68	4.103	68-74	3.340	68-80	2.514	68-86	1.910
69-69	3.851	69-75	3.147	69-81	2.324	69-87	1.798
70-70	3.593	70-76	2.946	70-82	2.155	70-88	1.661
71-71	3.345	71-77	2.752	71-83	2.004	71-89	1.464
72-72	3.128	72-78	2.550	72-84	1.875	72-90	1.189
73-73	2.935	73-79	2.355	73-85	1.768	73-91	0.937
74-74	2.797	74-80	2.172	74-86	1.692	74-92	0.708
75-75	2.648	75-81	2.017	75-87	1.605	75-93	0.575
76-76	2.490	76-82	1.877	76-88	1.497	76-94	0.481
77-77	2.340	77-83	1.756	77-89	1.339	77-95	0.421
78-78	2.170	78-84	1.639	78-90	1.097		
79-79	1.967	79-85	1.524	79-91	0.863		
80-80	1.758	80-86	1.416	80-92	0.638		
81-81	1.600	81-87	1.320	81-93	0.51[illegible]		
82-82	1.472	82-88	1.225	82-94	0.427		
83-83	1.364	83-89	1.09[illegible]	83-95	0.379		
84-84	1.276	84-90	0.902				
85-85	1.212	85-91	0.725				
86-86	1.172	86-92	0.556				
87-87	1.127	87-93	0.459				
88-88	1.071	88-94	0.396				
89-89	0.9[illegible]9	89-95	0.364				
90-90	0.718						
91-91	0.516						
92-92	0.326						
93-93	0.236						
94-94	0.190						
95-95	0.024						

TABLE V. *Showing the Values of two Joint Lives, according to the Probabilities of the Duration of Human Life among Males and Females collectively.*

Interest 4 per cent.

Difference of age 24, 30, 36, and 42 years.

Ages.	Values.	Ages.	Values.	Ages.	Values.	Ages.	Values.
1-25	12.832	1-31	12.196	1-37	11.46[illegible]	1-43	10.546
2-26	13.409	2-32	12.730	2-38	11.915	2-44	10.946
3-27	13.778	3-33	13.066	3-39	12.[illegible]64	3-45	11.168
4-28	14.003	4-34	13.264	4-40	12.234	4-46	11.260
5-29	14.037	5-35	13.277	5-41	12.24[illegible]	5-47	11.183
6-30	14.033	6-36	13.242	6-42	12.135	6-48	11.064
7-31	14.006	7-37	13.170	7-43	12.112	7-49	10.9[illegible]5
8-32	13.944	8-38	13.059	8-44	12.004	8-50	10.743
9-33	13.855	9-39	12.913	9-45	11.865	9-51	10.560
10-34	13.741	10-40	12.743	10-46	11.694	10-52	10.357
11-35	13.604	11-41	12.563	11-47	11.493	11-53	10.140
12-36	13.428	12-42	12.379	12-48	11.259	12-54	9.898
13-37	13.234	13-43	12.[illegible]96	13-49	11.011	13-55	9.644
14-38	13.023	14-44	11.997	14-50	10.759	14-56	9.371
15-39	12.798	15-45	11.787	15-51	10.514	15-57	9.087
16-40	12.570	16-46	11.562	16-52	10.264	16-58	8.799

Survivorship.

Interest 4 per cent.

Ages.	Values.	Ages.	Values.	Ages.	Values.	Ages.	Values.
17-41	12.351	17-47	11.320	17-53	10.018	17-59	8.503
18-42	12.146	18-48	11.076	18-54	9.761	18-60	8.208
19-43	11.951	19-49	10.819	19-55	9.500	19-61	7.928
20-44	11.751	20-50	10.567	20-56	9.228	20-62	7.658
21-45	11.550	21-51	10.332	21-57	8.95[illegible]	21-63	7.396
22-46	11.335	22-52	10.092	22-58	8.675	22-64	7.127
23-47	11.107	23-53	9.852	23-59	8.385	23-65	6.851
24-48	10.862	24-54	9.602	24-60	8.097	24-66	6.566
25-49	10.612	25-55	9.347	25-61	7.823	25-67	6.275
26-50	10.364	26-56	9.080	26-62	7.557	26-68	5.986
27-51	10.130	27-57	8.807	27-63	7.[illegible]97	27-69	5.702
28-52	9.894	28-58	8.534	28-64	7.03[illegible]	28-70	5.415
29-53	9.659	29-59	8.250	29-65	6.761	29-71	5.136
30-54	9.413	30-60	7.967	30-66	6.48[illegible]	30-72	4.881
31-55	9.167	31-61	7.702	31-67	6.197	31-73	4.646
32-56	8.91[illegible]	32-62	7.446	32-68	5.947	32-74	4.453
33-57	8.651	33-63	7.196	33-69	5.642	33-75	4.251
34-58	8.389	34-64	6.94[illegible]	34-70	5.364	34-76	4.040
35-59	8.[illegible]14	35-65	6.679	35-71	5.093	35-77	3.333
36-60	7.83[illegible]	36-66	6.40[illegible]	36-72	4.840	36-78	3.605
37-61	7.561	37-67	6.115	37-73	4.603	37-79	3.352
38-62	7.296	38-68	5.823	38-74	4.405	38-80	3.098
39-63	7.033	39-69	5.543	39-75	4.195	39-81	2.889
40-64	6.763	40-70	5.254	40-76	3.975	40-82	2.710
41-65	6.492	41-71	4.977	41-77	3.762	41-83	2.553
42-66	6.22[illegible]	42-72	4.730	42-78	3.539	42-84	2.418
43-67	5.957	43-73	4.50[illegible]	43-79	3.[illegible]95	43-85	2.305
44-68	5.689	44-74	4.322	44-80	3.052	44-86	2.203
45-69	5.426	45-75	4.128	45-81	2.854	45-87	2.083
46-70	5.153	46-76	3.921	46-82	2.684	46-88	1.933
47-71	4.884	47-77	3.715	47-83	2.533	47-89	1.708
48-72	4.633	48-78	3.489	48-84	2.396	48-90	1.385
49-73	4.39[illegible]	49-79	3.230	49-85	2.277	49-91	1.090
50-74	4.205	50-80	2.990	50-86	2.171	50-9	0.818
51-75	4.00[illegible]	51-81	2.792	51-87	2.050	51-93	0.662
52-76	3.803	52-82	2.623	52-88	1.901	52-94	0.551
53-77	3.605	53-83	2.475	53-89	1.681	53-95	0.468
54-78	3.389	54-84	2.344	54-90	1.366		
55-79	3.150	55-85	2.23[illegible]	55-91	1.078		
56-80	2.909	56-86	2.130	56-92	0.810		
57-81	2.7[illegible]0	57-87	2.010	57-93	0.655		
58-82	2.539	58-88	1.864	58-94	0.546		
59-83	2.385	59-89	1.644	59-95	0.464		
60-84	2.243	60-90	1.333				
61-85	2.[illegible]55	61-91	1.050				
62-86	2.037	62-92	0.789				
63-87	1.9[illegible]6	63-93	0.639				
64-88	1.790	64-94	0.533				
65-89	1.585	65-95	0.456				
66-90	1.290						
67-91	1.017						
68-92	0.764						
69-93	0.617						
70-94	0.514						
71-95	0.411						

Survivorship.

The values of joint lives in these tables have been computed for only one rate of interest; and of single lives in Table III. for only two rates of interest. The following rules will show, that it would be a needless labour to compute these values (in strict conformity to the observations) for any other rates of interest.

Account of a method of deducing, from the correct values (according to any observations) of any single or joint Lives at one rate of Interest, the same values at other rates of Interest.

Preliminary Problems.

Prob. I. The expectation given of a single life by any table of observations, to find its value, supposing the decrements of life equal, at any given rate of interest.

Solution. Find the value of an annuity certain for a number of years equal to twice the expectation. Multiply this value by the perpetuity increased by unity, and divide the product by twice the expectation: The quotient subtracted from the perpetuity will be the value required.

Example. The expectation of a male life aged 10, by the Sweden observations, is 43.94. Twice this expectation is 87.88. The value of an annuity certain for 87.88 years is (reckoning interest at 4 per cent.) 24.200. The product of 24.200 into 26 (the perpetuity increased by unity) is 629.2, which, divided by 87.88, gives 7.159. And this quotient subtracted from 25 (the perpetuity) gives 17.84 years purchase, the value of a life aged ten, deduced from the expectation of life at that age, according to the Sweden observations. (See the Tables in Dr Price on Reversions, vol. ii.).

Prob. II. Having the expectations given of any two lives by any table of observations, to deduce from thence the value of the joint lives at any rate of interest, supposing an equal decrement of life.

Solution. Find the difference between twice the expectation of the youngest life and twice the expectation of the oldest life increased by unity and twice the perpetuity. Multiply this difference by the value of an annuity certain for a time equal to twice the expectation of the oldest life; and by twice the same expectation divide the product, reserving the quotient.

From twice the perpetuity subtract the reserved quotient, and multiply the remainder by the perpetuity increased by unity. This last product divided by twice the expectation of the youngest life, and then subtracted from the perpetuity, will be the required value.

When twice the expectation of the youngest life is greater than twice the expectation of the oldest life increased by unity and twice the perpetuity, the reserved quotient, instead of being subtracted from twice the perpetuity, must be added to it, and the sum, not the difference, multiplied by the perpetuity increased by unity.

Example. Let the joint lives proposed be a female life aged 10, and a male life aged 15; and let the table of observations be the Sweden table for lives in general, and the rate of interest 4 per cent. Twice the expectations of the two lives are 90.14 and 83.28.

Twice the expectation of the oldest life, increased by unity and twice the perpetuity, is 134.28, which lessened by 90.14 (twice the expectation of the youngest life), leaves 44.14 for the reserved remainder. This remainder multiplied by 24.045 (the value of an annuity certain for 83.28 years, and the product divided by 83.28 (twice the expectation of the oldest life), gives 12.744, the quotient to be reserved; which subtracted from double the perpetuity, and the remainder (or 37.255) multiplied by the perpetuity increased by unity (or by 26) gives 968.630, which divided by 90.14 (twice the expectation of the youngest life) and the quotient subtracted from the perpetuity, we have 14.254 for the required value.

The value of an annuity certain, when the number of years is a whole number with a fraction added (as will be commonly the case) may be best computed in the following manner. In this example the number of years is 83.28. The value of an annuity certain for 83 years is 24.035. The same value for 84 years is 24.072. The difference between these two values is 0.37; which difference multiplied by .28 (the fractional part of the number of years), and the product (.0103) added to the least of the two values, will give 24.045 the value for 83.28 years.

General Rule. Call the correct value (supposed to be computed for any rate of interest) the first value. Call the value deduced (by the preceding problems) from the expectations at the same rate of interest, the second value. Call the value deduced from the expectations for any other rate of interest the third value.

Then the difference between the first and second values added to or subtracted from the third value, just as the first is greater or less than the second, will be the value at the rate of interest for which the third value has been deduced from the expectations.

The following examples will make this perfectly plain.

Example I. In the two last tables the correct values are given of two joint lives among mankind at large, without distinguishing between males and females, according to the Sweden observations, reckoning interest at 4 per cent. Let it be required to find from these values the values at 3 per cent. and let the ages of the joint lives be supposed 10 and 10.

The correct value by Table IV. (reckoning interest at 4 per cent.) is 16.141. The expectation of a life aged 10 is 45.07. The value deduced from this expectation at 4 per cent. by Prob. II. is 14.539. The value deduced by the same problem from the same expectation at 3 per cent. is 16.808. The difference between the first and second values is 1.602, which, added to the third value (the first being greater than the second), makes 18.410, the value required.

Example II. Let the value be required of a single male life aged 10, at 3 per cent. interest, from the correct value at 4 per cent. according to the Sweden observations.

First, or correct value at 4 per cent. (by Table III.) is 18.674. The expectation of a male life aged 10 is 43.94.

The second value (or the value deduced from this expectation by Prob. I.) is 17.838.

The third value (or the value deduced from the same expectation at 3 per cent.) is 21.277.

The difference between the first and second is .836; which (since the first is greater than the second) must be added to the third; and the sum (that is, 22.113) will be the value required.

The

Survivorship, Surya.

The third value at 5 per cent. is 15.286; and the difference added to 15.286 makes 16.122 the value of a male life aged 10 at 5 per cent. according to the Sweden observations. The exact value at 5 per cent. is (by Table III.) 16.014.

Again: the difference between 16.014 (the correct value at 5 per cent.). and 15.286 (the value at the same interest deduced from the expectation), is .728; which, added (because the first value is greater than the second) to 13.335 (the value deduced at 6 per cent. from the expectation) gives 14.063, the value of the same life, reckoning interest at 6 per cent.

These deductions, in the case of single lives particularly, are so easy, and give the true values so nearly, that it will be scarcely ever necessary to calculate the exact values (according to any given observations) for more than one rate of interest.

If, for instance, the correct values are computed at 4 per cent. according to any observations, the values at 3, $3\frac{1}{2}$, $4\frac{1}{2}$, 5, 6, 7, or 8 per cent. may be deduced from them by the preceding rules as occasion may require, without much labour or any danger of considerable errors. The values thus deduced will seldom differ from the true values so much as a tenth of a year's purchase. They will not generally differ more than a 20th or 30th of a year's purchase. In joint lives they will differ less than in single lives, and they will come equally near to one another whatever the rates of interest are.

The preceding tables furnish the means of determining the exact differences between the values of annuities, as they are made to depend on the survivorship of any male or female lives; which hitherto has been a *desideratum* of considerable consequence in the doctrine of life annuities. What has made this of consequence is chiefly the multitude of societies lately established in this and foreign countries for providing annuities for widows. The general rule for calculating from these tables the value of such annuites is the following.

Rule. "Find in Table III. the value of a female life at the age of the wife. From this value substract the value in Table IV. of the joint continuance of two lives at the ages of the husband and wife. The remainder will be the value in a single present payment of an annuity for the life of the wife, should she be left a widow. And this last value divided by the value of the joint lives increased by unity, will be the value of the same annuity in annual payments during the joint lives, and to commence immediately."

Example. Let the age of the wife be 24, and of the husband 30. The value in Table III. (reckoning interest at 4 per cet.) of a female life aged 24, is 17.252. The value in Table IV. of two joint lives aged 24 and 30, is 13.455, which substracted from 17.252 leaves 3.797, the value in a single present payment of an annuity of 1l. for the life of the wife after the husband; that is, for the life of the widow. The annuity, therefore, being supposed 20l. its value in a single payment is 20 multiplied by 3.797, that is, 75.94l. And this last value divided by 14.455 (that is, by the value of the joint lives increased by unity), gives 5.25, the value in annual payments beginning immediately, and to be continued during the joint lives of an annuity of 20l. to a wife aged 24 for her life, after her husband aged 30.

Surya ‖ Sussex.

SURYA, the orb of the sun personified and adored by a sect of Hindoos as a god. He seems to be the same divinity with the Phœbus of Greece and Rome; and the sect who pay him particular adoration are called *Sauras*. Their poets and painters describe his car as drawn by seven green horses, preceded by Arun, or the *Dawn*, who acts as his charioteer, and followed by thousands of genii worshipping him and modulating his praises. He has a multitude of names, and among them twelve epithets which denote his distinct powers in each of the twelve months; and he is believed to have descended frequently from his car in a human shape, and to have left a race on earth, who are equally renowned in the Indian stories with the Heliadai of Greece: it is singular, that his two sons called *Aswinau* or *Aswinicumarau*, in the dual, should be considered as twin-brothers, and painted like Castor and Pollux.

Asiatic Researches, vol. i. p. 262. and 263.

SUS, the Hog, a genus of quadrupeds. See Mammalia *Index*.

SUSA, the ancient royal residence of the kings of Persia, built by Darius Hystaspis, according to Pliny; though he probably only restored it, being a very ancient city, founded by Tithonus father of Memnon. Its compass was said by ancient authors to be 120 stadia; but the ruins give us the idea of a still greater extent. They are situated on the east side of the river Kerah, in the latitude of 32°, stretching not less than twelve miles from one extremity to the other. These ruins consist of hillocks of earth and rubbish, covered with broken pieces of brick and coloured tile. One of these hillocks is a mile in circumference, and 100 feet high. Another, though not quite so high, has double the circuit. Large blocks of marble covered with hieroglyphics are frequently discovered by the Arabs. There is a building, apparently modern, called the tomb of Daniel. The whole place is now a gloomy wilderness, inhabited by beasts of prey. See Kinneir's *Geographical Memoir of Persia*.

SUSPENSION, in *Scots Law*. See Law, N° clxxxv. 5, 6, and 7.

SUSSEX, a county of England, deriving its name from its situation in respect of the other Saxons, and called *Sussex*, i. e. the country of the South Saxons, has Hampshire on the west, the British channel on the south, Surrey on the north, and Kent on the east. Its length is 65 miles, its breadth 30, and its circumference 170. It is divided into 6 rapes, and these into 65 hundreds, in which are 342 parishes, of which 123 are vicarages, one city, 16 market towns, 1,140,000 acres, and in 1811 it contained 190,083 inhabitants. It has few good ports, though it lies along the channel for 65 miles, the coast being encumbered in many places with rocks; and where it is more open, such quantities of sand are thrown upon it by the south-west winds, and the harbours so choked up, that they will not admit vessels of any great draught or burden. The county is well watered by the rivers Arun, Adar, Ouse, Rother, Lavant, Cuckmeer, Ashburn, and Aften, by which it is well supplied with fish, as well as from the sea. Hence different places of the county are famed for different sorts of fish, as the Arun for mullets, which enter it from the sea in summer in shoals, and by feeding upon a particular kind of herb become extremely delicious: Chichester for lobsters, Selsey for cockles, Amberly for trout, Pulborough for eels, Rye for herrings, and

Gough's edition of Camden's Britannia, vol. i. p. 192.

Sussex, Sutherland.

and the county in general for carp. It is remarkable, that all the rivers above mentioned rise and fall into the sea, within the county.

The air, as well as the soil, is various in different parts of the county. Upon the coast the air is aguish, upon the hills and downs pleasant and wholesome; but somewhat moist and foggy in the valleys, the soil being deep and rich, and the vegetation in summer very vigorous. The downs in some places are very fertile in corn and grass; in others they feed great flocks of sheep, whose flesh and wool are very fine; but of the latter no inconsiderable quantity is clandestinely exported to France. In the Weald and the valleys the roads are very deep, especially in winter. In the north quarter are many woods, and some forests in other places; whence the king's yards are supplied with the largest and best timber in England, beside what is made into charcoal and consumed in the iron-works; for on the east side is plenty of iron ore, with furnaces, forges, and mills for manufacturing it. Those delicious birds called *wheat-ears* are bred in this shire; they are not bigger than a lark, but very fat. That part now called the *Wild* or *Weald* of Sussex, was anciently a mere desert for hogs and deer, of great extent, taking in a part of Kent and Surry; and was called *Andcrida Silva*, *Coid Andred*, and *Andradswald*, from Anderida an adjoining city. This county is in the home circuit and diocese of Chichester, giving the title of earl to the family of Yelverton, and sends 28 members to parliament, viz. two for the county, two for the city of Chichester, and two for each of the following towns, Horsham, Lewes, Bramber, East-Grinstead, Midhurst, Shoreham, Staining, Arundel, Hastings, Rye, Winchelsea, and Seaford; of which the four last are cinque ports. See SUSSEX, SUPPLEMENT.

SUTHERLAND, one of the most northerly counties of Scotland, bordering on Caithness to the east, and bounded by the ocean on the north, the country of Assynt on the west, Ross-shire on the south, and by the German sea on the south-east. It stretches about 70 miles in length, and 40 in breadth; it is generally hilly, though in many parts arable; well watered with small rivers and streams replete with fish, and containing about 60 lakes, the habitation of various fish, swans, ducks, geese, &c. One of the largest of these is Lochshin, extending 18 miles in length. Some of them are interspersed with small verdant islands, which in summer yield a very agreeable prospect. On the coast are many commodious harbours, and all the bays swarm with fish. Sutherland affords iron stone, freestone, limestone, marble and slate, in abundance. Turf and peat are the common fuel. Lead ore, and some copper ore, have been met with in some parts of the county.

The air is so temperate, and the soil so good, that saffron has here been brought to perfection. Many parts of the country are remarkably fruitful in corn, and the pasturage is everywhere excellent. Deer and some other game are abundant in Sutherland. On the hills are fed numerous flocks of sheep and black cattle. The northern part, called *Strathnaver*, and separated from the rest by a ridge of mountains, is bounded on the north by the Deucaledonian sea, on the west by the channel called the *Minch*, on the east by Caithness, and on the south by Assynt. The length from east to west, is 34 miles; but the breadth from north to south does not exceed 12 in some places. It is very hilly; and the mountains are so high, that the snow remains on the tops of them till midsummer. It is watered by the Naver, from whence it derives its name: this district gives a title to the eldest son of the earl of Sutherland. Strathnaver has many fresh-water lakes or lochs; the chief of which are Loch Naver and Loch Lyel: there are several islands on the northern coast. In various parts of the country there are monuments of victories obtained over the Danes or other foreign invaders. The inhabitants are hardy, bold, and enterprising; courteous to strangers; cheerful, open, frugal, and industrious. The salmon-fishery in this county is considerable, as well as the trade in black cattle, sheep, and horses, at the neighbouring fairs; corn, barley, salmon, butter, cheese, wool, hides, and tallow, are exported. Dornoch is the capital of the county. The population of Sutherland in 1811 amounted to 23,629. The following table shews the population at two different periods *.

Sutherland | Sutton.

* Statist. Hist. vol. xx.

	Parishes.	Population in 1755.	Population in 1790—798.
	Assynt	1934	3000
	Clyne	1406	1660
	Creich	1705	1730
	Durness	1000	1182
5	Dornoch	2780	2541
	Edderachyllis	869	1024
	Farr	2800	2600
	Golspie	1790	1700
	Kildonan	1433	1365
10	Lairg	1010	1350
	Loth	1193	1370
	Rogart	1761	2000
13	Tongue	1093	1439
		20,774	22,961

See SUTHERLAND, SUPPLEMENT.

SUTLER, in *War*, one who follows the army, and furnishes the troops with provision. Sutlers pitch their tents, or build their huts, in the rear of each regiment, and about head-quarters.

SUTRIUM, in *Ancient Geography*, a famous city, and an ancient colony of the Romans, the key of Etruria; founded about seven years after the taking of Rome by the Gauls (Velleius). Now *Sutri* in St Peter's patrimony, on the river Pozzolo; surrounded on every side with rocks, 24 miles to the north-west of Rome.

SUTTON, SAMUEL, was born at Alfreton in Derbyshire, and going into the army served under the duke of Marlborough in Queen Anne's wars with great credit. He afterwards came to London, commenced brewer, and kept a coffee-house in Aldersgate street, which was well frequented by the learned men of that time, by whom Mr Sutton was much respected, as a man of strong natural parts and uncultivated genius. About the year 1740 he schemed a very simple and natural method for extracting the foul air from the wells of ships, by pipes communicating with the fire-places of the coppers; which operated as long as any fire was kept burning for the ship's use. He took out a patent in 1744, to secure the profits of his invention; and died about the year 1752.

SUTURE,

Suture || Swammerdam.

SUTURE, in *Anatomy*, a kind of articulation peculiar to the cranium or skull. See ANATOMY, Part I. Sect. ii. *passim*.

SUTURE in *Surgery*, a method of uniting the lips of wounds together. See SURGERY.

SWABBER, an inferior officer on board ships of war, whose employment it is to see that the decks are kept clean and neat.

SWABIA. See SUABIA.

SWALLOW, a genus of birds. See HIRUNDO, ORNITHOLOGY *Index*. See also MIGRATION.

Swallow-Wort. See ASCLEPIAS, BOTANY *Index*.

SWAMMERDAM, JOHN, a celebrated and learned natural philosopher, was the son of John James Swammerdam, an apothecary and famous naturalist of Amsterdam, and was born in 1637. His father intended him for the church, and with this view had him instructed in Latin and Greek; but he, thinking himself unequal to so important a task, prevailed with his father to consent to his applying himself to physic. As he was kept at home till he should be properly qualified to engage in that study, he was frequently employed in cleaning his father's curiosities, and putting every thing in its proper place. This inspired our author with an early taste for natural history; so that, not content with the survey of the curiosities which his father had purchased, he soon began to make a collection of his own, which he compared with the accounts given of them by the best writers. When grown up, he seriously attended to his anatomical and medical studies; yet spent part of the day and the night in discovering, catching, and examining the flying insects proper to those times, not only in the province of Holland, but in those of Guelderland and Utrecht. Thus initiated in natural history, he went to the university of Leyden in 1651; and in 1653 was admitted a candidate of physic in that university. His attention being now engaged by anatomy, he began to consider how the parts of the body, prepared by dissection, could be preserved, and kept in constant order for anatomical demonstration; and herein he succeeded, as he had done before in his nice contrivances for dissecting and managing the minutest insects. Our author afterwards made a journey into France, where he spent some time at Saumur, and where he became acquainted with several learned men. In 1667 he returned to Leyden, and took his degree of Doctor of Physic. The next year the grand duke of Tuscany being in Holland in order to see the curiosities of the country, came to view those of our author and his father; and on this occasion Swammerdam made some anatomical dissections of insects in the presence of that prince, who was struck with admiration at our author's great skill in managing them, especially at his proving that the future butterfly lay with all its parts neatly folded up in a caterpillar, by actually removing the integuments that covered the former, and extricating and exhibiting all its parts, however minute, with incredible ingenuity, by means of instruments of inconceivable fineness. On this occasion the duke offered our author 12,000 florins for his share of the collection, on condition of his removing them himself into Tuscany, and coming to live at the court of Florence; but Swammerdam, who hated a court life, declined his highness's proposal. In 1663, he published a General History of Insects. About this time, his father began to take offence at his inconsiderately neglecting the practice of physic, which might have supported him in affluence; and would neither supply him with money nor clothes. This reduced him to some difficulties. In 1675 he published his History of the Ephemeras; and his father dying the same year, left him a fortune sufficient for his support; but he did not long survive him, for he died in 1682. Gaubius gave a translation of all his works from the original Dutch into Latin, from which they were translated into English, in folio, in 1758. The celebrated Boerhaave wrote his life.

Swammerdam || Sweden.

SWAN. See ANAS, ORNITHOLOGY *Index*.

SWANPAN, or Chinese ABACUS; an instrument for performing arithmetical operations. See ABACUS.

SWANEMOTE, SWAINMOTE, or SWEINMOTE. See *FOREST-Courts*.

SWEARING. See OATH.

SWEAT, a sensible moisture issuing from the pores of the skins of living animals. See PHYSIOLOGY, N° 286.

SWEATING SICKNESS, a disorder which appeared in England about the year 1481, and was by foreigners called the *English sweat*. See MEDICINE, N° 51.

SWEDEN,

1 Situation and extent.

ONE of the northern states of Europe, now occupies the whole of the north-western corner of that portion of the globe, lying between the gulf of Bothnia and the Atlantic. Before the treaty concluded in 1809, between Sweden and Russia, the Swedish territory extended over a considerable tract of country on the east of the gulf of Bothnia; but by that treaty the whole of these provinces were ceded to Russia. But on the other hand, Sweden, by a treaty signed at Kiel in January 1814, compelled Denmark to cede Norway to her; in return for which Denmark received Pomerania. Thus enlarged, Sweden possesses nearly the whole Scandinavian peninsula. Her territories are bounded on all sides by the sea, except the north-east, where they are bounded by the rivers Tornea and Tana. They extend from 55° 20′ to 71° of North latitude, and from 5° to 31° of East longitude. Their greatest length is 1180 English miles, their greatest breadth 500, and they embrace an area of 340,000 square miles, which is about one-tenth of the surface of Europe. She has now also the greatest extent of sea coast of any European power. But Sweden proper, apart from Norway, includes only an area of 195,000 square miles; and as the latter country is described in a separate article, our observations here shall be confined to the former. The following shows the present divisions of Sweden.

Stockholm,

2 Division.

	Extent in German sq. miles.	Arable Land in Tunnas.	Population in 1805.
Stockholm, (city)	—	400	72,651
Stockholm, (prov.)	123,	71,016	99,377
Upsala,	106,5	82,564	84,141
Sudermanland,	135,3	54,011	98,761
East Gothland	205,	104,061	162,859
Gothland,	49,2	30,044	32,988
Calmar,	196,8	66,121	136,296
Blekings,	57,2	21,715	67,200
Jonkopings,	200,9	53,684	117,381
Cronoberg,	164,	37,695	89,631
Christianstad,	102,5	89,344	120,547
Malmohus,	82,	222,609	149,892
Holland,	92,9	43,983	73,594
Gotheborg,	86,1	42,458	119,514
Elfsbord,	241,9	73,808	156,271
Skaraborg,	155,8	143,192	138,410
Orebro,	176,3	46,223	100,428
Carlstad,	299,3	82,473	140,100
Westmanland,	131,2	55,515	84,808
Kopparberg,	590,4	51,547	124,816
Geffleborg,	565,8	28,872	89,083
West Norland,	1,148	35,500	89,974
West Bothnia	4059	20,560	76,151
	8,963	1,445,395	2,424,874
Lakes,	180		
	(A) 9,143 equal to 195,000 square English miles.		

Population in 1818	2,615,400
Population of Norway (in 1803)	910,000
	3,525,400

The only colonial territory belonging to Sweden is the island of St Bartholomew, in the West Indies.

3 Face of the country. Sweden is diversified in a most picturesque manner, with extensive lakes, large rivers, winding streams, cataracts, gloomy forests, fertile vales, and stupendous rocks. But the most striking feature in the appearance of the country is the vast forests that cover its surface. "If the reader, says Dr Clarke *, cast his eyes upon the map of Sweden, and imagine the gulf of Bothnia to be surrounded by one unbroken forest, as ancient as the world, consisting principally of pine trees, with a few mingling birch and juniper trees, he will have a general and tolerably correct idea of the real appearance of the country. The population is yet small, because the whole country is covered with wood. The only region with which Sweden can properly be compared is North America; a land of wood and iron, with very few inhabitants."

* *Travels in Scandinavia, published in* 1815.

4 Soil. Sweden is by no means remarkable for the fertility of its soil, as appears from the above table. The land capable of tillage, it will be seen, amounts only to about 1,800,000 acres, or one acre in sixty of the whole surface of the country. But a great extent of land besides this ministers to the support of man, by affording pasturage for cattle and sheep; and probably much of what is now covered with wood is capable of cultivation if cleared.

The principal mountains belonging to Sweden are those of the elevated chain which divides it from Norway, and which branch off in a south-easterly direction. One of the highest of these Swucku. 5 Mountains.

The chief rivers are the Gotha connecting Lake Wener with the Categat; the Motala, forming the outlet of Lake Weter; the Dahl rising in the Norwegian mountains, and flowing through Dalecarlia into the gulf of Bothnia, and the Tornea forming the north-eastern boundary, and empting itself into the gulf of Bothnia at the town of the same name. 6 Rivers.

There are a vast number of lakes in all the provinces of Sweden. The most remarkable are Wener, Weter, and Maela, on the banks of which last stands the city of Stockholm. 7 Lakes.

The climate and seasons of Sweden nearly resemble those of the same latitudes in Russia. The winters are in most places extremely severe, and the summers short and sudden. The gulf of Bothnia is generally frozen over during winter, so as to admit of travellers passing over into Finland, and East Bothnia. The summer, though 8 Climate and seasons.

(A) The map of Sweden is united with that of Denmark and Norway, in Plate CLXX. The square German mile used in this table is equal to $21\frac{4}{10}$ square English miles. The tunna of land is equal $1\frac{1}{4}$ English acres nearly. The table is taken from Crome's View of the Powers of Europe, published in German at Leipzig, in 1818.

Sweden. though short, is generally hot, and seldom cloudy or inconstant. In the higher latitudes the sun of course is seen in the middle of summer for several days together, and the nights of winter are proportionably long. See LAPLAND.

9 Natural History. Much of the natural history of Sweden has been already given under the article LAPLAND. In the more southern provinces there are found in the forests the bear, lynx, wolf, beaver, otter, glutton, and flying squirrel. The Swedish horses are commonly small, but spirited, and are considered as superior to those of Germany for cavalry. The cattle and sheep are also small; goats are scarce, but swine are very numerous. Seals are found in the gulf of Bothnia; and the lakes and rivers of Sweden produce pike that are remarkably large, and which are salted and pickled for exportation. The forests produce a great variety of game, especially the large black cock, called in Scotland the cock of the forest. Among the reptiles the *rana bombina*, and the *coluber chersea*, are considered as almost peculiar to Sweden.

The chief vegetable productions of Sweden are its immense forests of pine and fir trees, though the country is not destitute of a great variety of shrubs and plants common to it with Denmark and Russia.

The principal riches of the natural history of Sweden are to be found in the mineral kingdom. It produces crystals, amethysts, topazes, porphyry, lapis lazuli, agate, cornelian, marble, and other fossils. The wealth of the country, however, arises chiefly from her mines of silver, copper, lead, and iron. According to Dr Thomson, who travelled in 1812, there were in Sweden 176 iron mines, which yielded annually about 1,200,000 hundred weights of metal. The annual produce of copper is about 1000 tons. The mines employ about 50,000 persons, exclusive of the artists who afterwards work up the metal into various manufactured articles.

There are likewise in Sweden some silver mines, of which that of Sahlberg is the richest, as well as the most ancient. It existed so early as 1188, and during the whole of the 14th century, it yielded 24,000 marks of silver per annum. In the 15th century the quantity was diminished to 20,000. In the reign of Charles X. it gave only 2000; and it furnishes at present still less, the ore yielding only one ounce of pure metal per quintal. The chief gallery, where the purest silver was obtained, having fallen in, is not yet cleared, notwithstanding their incessant labour. They are also digging pits in a perpendicular direction, in order to arrive at the principal vein, which extends itself from the north to the south-east. Formerly lead employed in separating the metal was imported from England; but the mine furnishes at present a sufficient quantity for the purpose. The most remarkable mineral waters in Sweden are those of Medewi in East Gothland.

10 Early history uncertain. The early history of Sweden is not less involved in fable than that of most other nations. Some historians have pretended to give regular catalogues of the princes who reigned in Sweden in very early times; but they differ so much that no credit can be given to them. All indeed agree that ancient Scandinavia was first governed by judges elected for a certain time by the voice of the people. Among these temporary princes the country was divided, until, in the year of the world 2054, according to some, or 1951, according to others, Eric, or, if we believe Puffendorf, Sueno, was raised to the supreme power, with the prerogatives of all the temporary magistrates united in his person for life, or until his conduct should merit deposition. Sweden.

From this very early period till the year 1366 of the Christian era, the histories of Sweden present us with nothing but what is common to all nations in their early periods, viz. the endless combats of barbarians, tending to no other purpose than the effusion of blood. At the time just mentioned, however, Albert of Mecklenburg, having concluded a peace between Sweden and Denmark, which had been at violent war for some time before, was proclaimed king of Sweden. The peace was of short duration, being broken in 1368; on which Albert entered into an offensive and defensive league with the earl of Holstein, the Jutland nobility, the dukes of Sleswick, Mecklenburg, and the Hanse-towns, against the kings of Denmark and Norway. Albert proved very successful against Waldemar king of Denmark at that time, driving him entirely out of his dominions; but he himself was defeated by the king of Norway, who laid siege to his capital. Soon after this, a new treaty was concluded, by which Albert was allowed to enjoy the crown of Sweden in peace. Having formed a design however of rendering himself absolute, he so displeased his subjects that Margaret of Norway was proclaimed queen of Sweden by the malecontents. A war immediately ensued, in which Albert was defeated and taken prisoner; but as the princes of Mecklenburg, the earls of Holstein, and the Hanse-towns, entered into a league in his favour, the war raged with more fury than ever. An. 1366. 11 Albert of Mecklenburg declared king. 12 War with Denmark and Norway. 13 Is defeated and taken prisoner by Margaret of Norway.

At length, in 1394, the contending parties were reconciled. Albert was set at liberty, on condition that he should in three years give up to Margaret all pretensions to the city of Stockholm; and the Hanse-towns engaged to pay the sum of 60,000 marks of silver if Albert should break that treaty. Not long after this, Eric the son of Albert died; and he, having no other child, did not think it worth his while to contend for the kingdom of Sweden: he therefore acquiesced in the pretensions of Margaret, and passed the remainder of his days at Mecklenburg. 14 Set at liberty. An. 1394.

Margaret died in 1415, and was succeeded by Eric of Pomerania. This prince's reign was cruel and oppressive. The consequence of this was a revolt; and Charles Canutson, grand mareschal of Sweden and governor of Finland, having joined the malecontents, was declared commander in chief of their army. Eric was now formally deposed: Canutson was chosen regent; but beginning to oppress the people, and aspiring openly to the crown, the Swedes and Danes revolted; in consequence of which a revolution took place, and Christopher duke of Bavaria, nephew to Eric, was chosen king of Denmark, Sweden, and Norway, in 1442. 15 Margaret is succeeded by Eric, a cruel tyrant. An. 1415.

On the accession of the new prince, complaints against Canutson were brought from all quarters; but through the interest of his friends, he escaped punishment; and in 1448, Christopher having died after a tyrannical reign of about five years, he was raised to the throne to which he had so long aspired. The kingdoms of Denmark and Norway however refused allegiance to him; on which a war immediately commenced. In 1454 peace was concluded, and Denmark for the present freed from the Swedish yoke. Nor did Canutson long enjoy even the crown of Sweden. Having quarrelled with the magistrates 16 Charles Canutson. An. 1448.

Sweden.

magistrates and the archbishop of Upsal, the latter formed such a strong party that the king could not resist him. Canutson died in 1470 after a long and turbulent reign.

An. 1520.

The Swedish affairs continued to be involved in dreadful confusion till the year 1520, when a great revolution was effected by Gustavus Ericson, a nobleman of the first rank, who restored the kingdom to its liberty, and laid the foundation of its future grandeur. The occasion of this great revolution was as follows: In 1518, Christiern king of Denmark invaded Sweden, with a design to subdue the whole country; but being defeated with great loss by young Steen Sture, at that time regent, he set sail for Denmark. But meeting with contrary winds, he made several descents on the Swedish coast, which he ravaged with all the fury of an incensed barbarian. The inhabitants, however, bravely defended themselves, and Christiern was reduced to the utmost distress; one half of his forces having perished with hunger, and the rest being in the most imminent danger by the approach of a rigorous winter. He then thought of a stratagem, which had almost proved fatal to the regent; for having invited him to a conference, at which he designed either to assassinate or take him prisoner, Sture was about to comply, had not the senate, who suspected the plot, interposed and prevented him. Christiern then offered to go in person to Stockholm in order to confer with Sture, on condition that six hostages should be sent in his room. This was accordingly done; but the wind happening then to prove favourable, he set sail for Denmark with the hostages, of whom Gustavus Ericson was one. Next year he returned; and having drawn Sture into an ambush, the regent received a wound of which he died some time after. The kingdom being thus left without a head, matters soon came to the most desperate crisis. The army disbanded itself; and the senate, instead of taking proper measures to oppose the enemy, spent their time in idle debates. Christiern in the mean time advanced into the heart of the kingdom, destroying every thing with fire and sword; but on his arrival at Stragnez, he granted a suspension of arms, on condition that they would elect him king. This they accordingly did; and Christiern proved one of the most bloody tyrants that ever sat on the throne of any kingdom. Immediately after his coronation, he gave grand entertainments for three days; during which time he projected the diabolical design of extirpating at once all the Swedish nobility, and thus for ever preventing the people from revolting, by depriving them of their proper leaders. As the tyrant had signed articles, by which he promised indemnity to all who had borne arms against him, it became necessary to invent some cause of offence against those whom he intended to destroy. To accomplish his purpose, Gustavus Trolle, formerly archbishop of Upsal, but who had been degraded from that dignity, in an oration before his majesty, lamented the demolition of Stecka, his place of residence, and the losses sustained by the see of Upsal, amounting to near a million of money. He then proceeded in a bitter accusation against the widow and the son-in-law of Sture the late regent, comprehending in the same accusation about 15 of the principal nobility, the whole senate, and the burghers of Stockholm. In consequence of this, about 60 of the principal nobility and people of first rank in Sweden were hanged as traitors. Innumerable other cruelties were committed; part of which are owned by the Danish historians, and minutely related by those of Sweden. At last he departed for Denmark, ordering gibbets to be erected, and causing the peasants to be hanged on them for the slightest offences.

17 Christiern king of Denmark invades Sweden, but is defeated and driven out.

18 He treacherously carries off six hostages, of whom Gustavus Ericson is one.

An. 1519.

19 Is chosen king, and proves a most bloody tyrant.

20 Massacres the nobility, and causes gibbets to be erected as he passes along.

This monstrous cruelty, instead of securing him on the throne, exasperated the whole nation against him. It has already been mentioned, that Gustavus Ericson, or, as he is commonly called, *Gustavus Vasa*, was among the number of the hostages whom Christiern had perfidiously carried to Denmark in 1519. Large promises had been made in order to reconcile him to Christiern, and all means had been employed, but in vain. Secret orders were given to strangle him in prison; but the officer to whom the assassination was committed remonstrated to the king about the consequences of it, and prevailed on him to change the sentence of death into close confinement in the castle of Copenhagen. Some of the hostages perished in consequence of the rigorous treatment they met with; but Gustavus withstood all hardships. At last one Banner, a Danish nobleman, prevailed on the king to put him into his hands, in order to try whether or not he could prevail on him to change his sentiments. The king, however, told Banner, that he must pay 6000 crowns if the prisoner should make his escape. Banner generously consented; and having brought the noble prisoner to his fortress of Calo in Jutland, soon allowed him all the liberty he could desire, and otherwise heaped favours on him. All this, however, could not extinguish his remembrance of the cruelties of Christiern, and the desire he had of being serviceable to his country. He therefore determined to make his escape; and the liberty he enjoyed soon put him in a capacity of effecting it. Having one day mounted his horse, under pretence of hunting as usual in the forest, when he got at a proper distance, he changed his dress to the habit of a peasant: and quitting his horse, travelled for two days on foot through by-paths, and over mountains almost impassable, arriving on the third at Flensburgh. Here no one was admitted without a passport: and Gustavus dreaded presenting himself to the governor or the officer on guard, for fear of being discovered. Gustavus hired himself to a cattle merchant; and in this disguise escaped out of the Danish territories, and arrived at Lubec.

21 Adventures of Gustavus Vasa or Ericson.

22 He escapes from Denmark.

23 Arrives at Lubec.

Banner was no sooner acquainted with his escape, than he set out after him with the utmost diligence, found him at Lubec, and reproached him with great warmth as ungrateful and treacherous; but he was soon appeased by the arguments urged by Gustavus, and especially by a promise of indemnifying him in the loss of his ransom. On this Banner returned, giving out that he could not find his prisoner. Christiern was enraged at his escape, apprehending that he might reverse all his designs in Sweden; and gave orders to Otho his general to make the strictest search, and leave no means untried to arrest him. Gustavus applied to the regency for a ship to convey him to Sweden, where he hoped he should be able to form a party against the Danes. He likewise endeavoured to draw the regency of Lubec into his measures; and reasoned with so much zeal and ability, that Nicholas Gemins, first consul, was entirely gained; but the regency could never be prevailed on to declare for a party without friends, arms, money, or credit. Before his departure, however, the consul gave him

24 Attempts in vain to draw the regency of Lubec over to his side.

Sweden. him assurances, that if he could raise a force sufficient to make head against the enemy in the field, he might depend on the services of the republic, and that the regency would immediately declare for him. Gustavus desired to be landed at Stockholm; but the captain of the ship, either having secret orders to the contrary, or business elsewhere, steered a different course, and put him on shore near Calmar; a city then garrisoned by the troops of Christiana widow of the regent. In fact, the governor held this place for his own purposes, and only waited to make the best terms he could with the Danes. When Gustavus arrived, he made himself known to him and the principal officers of the garrison, who were mostly Germans, and his fellow-soldiers in the late administrator's army; but the mercenary band, seeing him without troops and without attendants, regarded him as a desperate person devoted to destruction, refused to embrace his proposals, and even threatened to kill or betray him, if he did not instantly quit the city.

25 He arrives at Calmar, but meets with an unfavourable reception.

Disappointed in his expectations, Gustavus departed; and his arrival being now publicly known, he was again forced to have recourse to his peasant's disguise to conceal him from the Danish emissaries dispersed over the country to search for him. In a waggon loaded with hay he passed through the Danish army, and at last repaired to an old family castle in Sudermania. Hence he wrote to his friends, intimating his return to Sweden, and beseeching them to assemble all their forces in order to break through the enemy's army into Stockholm, at that time besieged; but they refused to embark in so hazardous and desperate an attempt.

26 His friends refuse to assist him.

Gustavus next applied himself to the peasants; but they answered, that they enjoyed salt and herrings under the government of the king of Denmark; and that any attempts to bring about a revolution would be attended with certain ruin, without the prospect of bettering their condition; for peasants they were, and peasants they should remain, whoever was king. At length, after several attempts to throw himself into Stockholm, after that city was surrendered to the king, after the horrid massacre of the senate, and after running a thousand dangers, and undergoing hardships and fatigues scarcely to be supported by human nature, he formed the resolution of trying the courage and affection of the Dalecarlians. While he was in the deepest obscurity, and plunged in almost insurmountable adversity, he never relinquished his designs nor his hopes. The news of the massacre had, however, nearly sunk him into despondency, as by it he lost all his friends, relations, and connections, and indeed almost every prospect of safety to himself or deliverance to his country. This suggested the thought of going to Dalecarlia, where he might live with more security in the high mountains and thick woods of that country, if he should fail in the attempt of exciting the inhabitants to revolt.

27 Applies in vain to the peasants.

Attended by a peasant, to whom he was known, he travelled in disguise through Sudermania, Nericia, and Westermania, and, after a laborious and painful journey, arrived in the mountains of Dalecarlia. Scarcely had he finished his journey, when he found himself deserted by his companion and guide, who carried off with him all the money which he had provided for his subsistence. Thus forlorn and destitute, he entered among the miners, without relinquishing his hopes of one day ascending the throne of Sweden. His whole object for the present was to live concealed, and gain a maintenance, till fortune should effect something in his favour: nor was it long before this happened. A woman in the mines perceived, under the habit of a peasant, that the collar of his shirt was embroidered. This circumstance excited curiosity; and the graces of his person and conversation, which had something in them to attract the notice of the meanest of the vulgar, afforded room for suspicion that he was some person of quality in disguise, forced by the tyranny of the government to seek shelter in these remote parts. The story came to the ears of a neighbouring gentleman, who immediately went to the mines to offer his protection to the unfortunate stranger; and was astonished on recognizing the features of Gustavus, to whom he had been known at the university of Upsal. Touched with compassion at the deplorable situation of so distinguished a nobleman, he could scarcely refrain from tears. At night he sent for Gustavus, made him an offer of his house, and gave him the strongest assurances of his friendship and protection. He told him, he would there meet with better accommodations, and as much security as in the mines; and that, should he chance to be discovered, he would, with all his friends and vassals, take arms in his defence.

28 Arrives in Dalecarlia, is robbed by his guide, and obliged to work in the mines.

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29 Is discovered and relieved.

This offer was embraced by Gustavus with joy, and he remained for some time at his friend's house; but finding it impossible to induce him to take part in his designs, he quitted him, and fled to one Peterson, a gentleman whom he had formerly known in the service. This man received Gustavus with all the appearance of kindness; and on the very first proposal, offered to raise his vassals. He even named the lords and peasants whom he pretended to have engaged in his service; but in a few days, he went secretly to a Danish officer, and gave him information of what had passed. The officer immediately caused the house to be surrounded with soldiers, in such a manner that it seemed impossible for Gustavus to escape. Being warned, by Peterson's wife of the treachery of her husband, he, by her direction, contrived to flee to the house of a clergyman, her friend, by whom he was received with all the respect due to his birth and merit; and lest the domestic who conducted him should follow the treacherous example of his master, he removed him to the church, and conducted him to a small closet, of which he kept the key. Having lived for some time in this manner, Gustavus began to consult with his friend concerning the most proper method of putting their schemes in execution. The priest advised him to apply directly to the peasants themselves; told him that it would be proper to spread a report, that the Danes were to enter Dalecarlia in order to establish new taxes by force of arms; and as the annual feast of all the neighbouring villages was to be held in a few days, he could not have a more favourable opportunity: he also promised to engage the principal persons of the diocese in his interest.

30 Has a very narrow escape from the Danes.

In compliance with this advice, Gustavus set out for Mora, where the feast was to be held. He found the peasants already informed of his designs, and impatient to see him. Being already prepossessed in his favour, they were soon excited to an enthusiasm in his cause, and

31 His cause espoused by the peasants of Dalecarlia.

Sweden. and instantly resolved to throw off the Danish yoke. In this design they were more confirmed by their superstition; some of their old men having observed that the wind had blown from the north while Gustavus was speaking, which among them was reckoned an infallible omen of success. Gustavus did not allow their ardour to cool, but instantly led them against the governor's castle: which he took by assault, and put the garrison to the sword. This inconsiderable enterprise was attended with the most happy consequences. Great numbers of the peasants flocked to his standard; some of the gentry openly espoused his cause, and others supplied him with money. Christiern was soon informed of what had passed; but despising such an inconsiderable enemy, he sent only a slender detachment to assist his adherents in Dalecarlia. Gustavus advanced with 5000 men, and defeated a body of Danes; but he was strenuously opposed by the archbishop of Upsal, who raised numerous forces for Christiern. The fortune of Gustavus, however, still prevailed, and the archbishop was defeated with great loss. Gustavus then laid siege to Stockholm; but his force being unequal to such an undertaking, he was forced to abandon it with loss.

32 The Danes defeated.

This check did not prove in any considerable degree detrimental to the affairs of Gustavus; the peasants from all parts of the kingdom flocked to his camp, and he was joined by a reinforcement from Lubec. Christiern, unable to suppress the revolt, wreaked his vengeance on the mother and sisters of Gustavus, whom he put to death. His barbarities served only to make his enemies more resolute. Gustavus having assembled the states at Wadstena, he was unanimously chosen regent, the diet taking an oath of fidelity to him, and promising to assist him to the utmost. Having thus obtained the sanction of legal authority, he pursued his advantages against the Danes. A body of troops appointed to throw succours into Stockholm were cut in pieces; and the regent sending some troops into Finland, struck the Danes there with such terror, that the archbishop of Upsal, together with the Danish governors, fled to Denmark. Christiern then sent express orders to all his governors and officers in Finland and Sweden to massacre the Swedish gentry without distinction. The Swedes made reprisals by massacring all the Danes they could find; so that the whole country was filled with slaughter.

33 Horrid cruelty of King Christiern.

34 Success of Gustavus.

In the mean time Gustavus had laid siege to the towns of Calmar, Abo, and Stockholm; but Norby found means to oblige him to raise them with loss. Gustavus, in revenge, laid siege to the capital a third time, and applied to the regency of Lubec for a squadron of ships and other succours for carrying on the siege. This was granted on condition that Gustavus should oblige himself, in the name of the states, to pay 60,000 merks of silver as the expence of the armament; that, until the kingdom should be in a condition to pay that sum, the Lubec merchants trading to Sweden should be exempted from all duties on imports or exports; that all other nations should be prohibited from trading with Sweden, and that such traffic should be deemed illicit; that Gustavus should neither conclude a peace, nor even agree to a truce, with Denmark, without the concurrence of the regency of Lubec; and that if the republic should be attacked by Christiern, he should enter Denmark at the head of 20,000 men. On these hard terms Gustavus obtained assistance from the regency of Lubec; nor did his dear-bought allies prove very faithful. They did not indeed go over to the enemy; but in a sea-fight, where the Danes were entirely in the power of their enemies, they suffered them to escape, when their whole force might have been entirely destroyed. This treachery had nearly ruined the affairs of Gustavus; for Norby was now making preparations effectually to relieve Stockholm; in which he would probably have succeeded: but at this critical period news arrived that the Danes had unanimously revolted, and driven Christiern from the throne; and that the king had retired into Germany, in hopes of being restored by the arms of his brother-in-law the emperor. On hearing this news, Norby retired with his whole fleet to the island of Gothland, leaving but a slender garrison in Calmar. Gustavus did not fail to improve this opportunity to his own advantage, and quickly made himself master of Calmar. Mean time Stockholm continued closely invested; but Gustavus thought proper to protract the siege till he should get himself elected king. Having for this purpose called a general diet, he first filled up the vacancy in the senate occasioned by the massacres of Christiern. Gustavus had the address to get such nominated as were in his interest. The assembly was no sooner met, than a speech was made, containing the highest encomiums on Gustavus, setting forth in the strongest light the many eminent services he had done for his country, and concluded that the states would show themselves equally ungrateful and blind to their own interest if they did not immediately elect him king. This proposal was acceded to by such tumultuous acclamations that it was impossible to collect the votes; so that Gustavus himself acknowledged, that their affection exceeded his merit, and was more agreeable to him than the effects of their gratitude. He was urged to have the ceremony of his coronation immediately performed: but this he delayed, in consequence of some designs which he had formed to reduce the exorbitant power of the clergy. Gustavus had himself embraced the doctrines of the reformed religion, and did all in his power to establish the reformation in his new kingdom. His design could not fail to raise against him the enmity of the clergy, and of all the more supertitious part of his subjects. Accordingly, the first years of his reign were embittered by internal disturbances and revolts, which were aided and fomented by the deposed Christiern, who was at one time very near regaining possession of the Swedish dominions.

35 He is chosen king of Sweden. An. 1523.

Christiern having established a powerful interest in Norway, once more made an attempt to recover his kingdoms, and was joined by the Dalecarlians; but being defeated by the Swedish forces, he was forced to return to Norway, where, being obliged to capitulate with the Danish generals, he was kept prisoner all his life.

36 Unsuccessful attempt of Christiern.

In 1542, Gustavus having happily extricated himself out of all his troubles, prevailed on the states to make the crown hereditary in his family; after which he applied himself to the encouragement of learning and commerce. A treaty was set on foot for a marriage between his eldest son Eric and Elizabeth queen of England; but this negotiation failed of success.

37 Unsuccessful negotiation for a marriage with Queen Elizabeth. An. 1542.

Gustavus Vasa died in 1560, and was succeeded by his

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his son Eric XIV. The new king was possessed of all the exterior ornaments which gave an air of dignity to the person; but he had neither the prudence nor the penetration of his father. He created the first nobility that were ever known in Sweden; but this he had no sooner done than he quarrelled with them, by passing some act, which they thought derogatory to their honour and dignity. The whole course of his reign was disturbed by wars with Denmark, and disputes with his own subjects. In the former he was unfortunate, and towards the latter he behaved with the greatest cruelty. At last, he is said to have become mad. He afterwards recovered his senses, but was soon dethroned by his brothers: of whom Duke John succeeded him in the kingdom.

38 Gustavus dies, and is succeeded by Eric, a weak and imprudent prince. An. 1560.

39 Eric deposed, and succeeded by his brother John.

This revolution took place in the year 1568, but with no great advantage to Sweden. Disputes about religion between the king and his brothers, and wars with Russia, threw matters into the utmost confusion. At last Prince Sigismund, the king's son, was chosen king of Poland, which proved the source of much trouble to the kingdom. In 1590 King John died; and as Sigismund was at a distance, every thing fell into the utmost confusion: the treasury was plundered, and the royal wardrobe quite spoiled, before even Duke Charles could come to Stockholm to take on himself the administration until King Sigismund should return. This, however, was far from being the greatest disaster which befel the nation at this time. It was known that the king had embraced the Popish religion, and it was with good reason suspected that he would attempt to restore it upon his arrival in Sweden. Sigismund was also obliged, on leaving Poland, to promise that he would stay no longer in Sweden than was necessary to regulate his affairs. These circumstances served to alienate the minds of the Swedes from their sovereign even before they saw him; and the universal dissatisfaction was increased, by seeing him attended on his arrival in Sweden in 1593, by the pope's nuncio, to whom he made a present of 30,000 ducats to defray the expences of his journey to Sweden.

40 Prince Sigismund chosen king of Poland. An. 1568.

41 Succeeds to the crown of Sweden. An. 1590.

What the people had foreseen was too well verified: the king refused to confirm the Protestants in their religious privileges, and showed such partiality on all occasions to the Papists, that a party was formed against him; at the head of which was Duke Charles his uncle. Remonstrances, accompanied with threats, took place on both sides. Sigismund was apparently reconciled to his brother, and promised to comply with the inclinations of the people, though without any inclination to perform what he had promised. The agreement, indeed, was scarcely made, before Sigismund conceived the horrid design of murdering his uncle at the Italian comedy acted the night after his coronation. The duke, however, having notice of the plot, found means to avoid it. This enraged the king so much, that he had resolved to accomplish his designs by force; and therefore commanded a Polish army to march towards the frontiers of Sweden, where they committed all the ravages that could be expected from an enraged and cruel enemy. Complaints were made by the Protestant clergy to the senate: but no other reply was made them, than that they should abstain from those bitter invectives and reproaches, which had provoked the Catholics, till the king's departure; at which time they would be at more liberty.

42 A party formed against him.

43 Forms a design of murdering his uncle.

In 1595 Sigismund set sail for Dantzic, leaving the administration in the hands of Duke Charles. The consequence of this was, that the dissensions which had already taken place being continually increased by the obstinacy of the king, Duke Charles assumed the sovereign power; and in 1604 Sigismund was formally deposed, and his uncle Charles IX. raised to the throne. He proved a wise and brave prince, restoring the tranquillity of the kingdom, and carrying on a war with vigour against Poland and Denmark. He died in 1611, leaving the kingdom to his son, the celebrated Gustavus Adolphus.

44 Sigismund deposed, and is succeeded by Charles IX. Ann. 1604.

Though Charles IX. by his wise and vigorous conduct had in a great measure retrieved the affairs of Sweden, they were still in a very bad situation. The finances of the kingdom were entirely drained by a series of wars and revolutions; powerful armies were preparing in Denmark, Poland, and Russia, while not only the Swedish troops were inferior in number to their enemies, but the government was destitute of resources for their payment.

45 State of Sweden on the accession of Gustavus Adolphus. An. 1611.

Though the Swedish laws required that the prince should have attained his 18th year before he was of age, yet such striking marks of the great qualities of Gustavus appeared, that he was allowed by the states to take on him the administration even before this early period. His first act was to resume all the crown-grants, that he might be the better able to carry on the wars in which he was engaged; and to fill all places, both civil and military, with persons of merit. At the head of domestic and foreign affairs was placed Chancellor Oxenstiern, a person every way equal to the important trust, and the choosing of whom impressed Europe with the highest opinion of the young monarch's penetration and capacity.

46 He is allowed to assume the administration while yet a minor.

Soon after his accession, Gustavus received an embassy from James I. of Britain, exhorting him to make peace with his neighbours. This was seconded by another from Holland. But as the king perceived that the Danish monarch intended to take every opportunity of crushing him, he resolved to act with such vigour, as might convince him that he was not easily to be overcome. Accordingly he invaded Denmark with three different armies at once; and though the enemy's superiority at sea gave them great advantages, and the number of the king's enemies distracted his attention, he carried on the war with such spirit, that in 1613 a peace was concluded on good terms. This war being finished, the king applied himself to civil polity, and made some reformation in the laws of Sweden. In 1615, hostilities were commenced against Russia, on account of the refusal of that court to restore some money which had been formerly lent them. The king entered Ingria, took Kexholm by storm, and was laying siege to Plescov, when, by the mediation of James I. peace was concluded, on condition of the Russians repaying the money, and yielding to Sweden some part of their territory. In this and the former war, notwithstanding the shortness of their duration, Gustavus learned the rudiments of the military art for which he soon became so famous. He is said, indeed, to have taken every opportunity of improvement with a quickness of understanding seemingly more than human. In one campaign, he not only learned, but improved all the military maxims of La Gardie, a celebrated general, brought the Swedish army to a more steady and regular disciple, and formed an invincible

47 He invades Denmark and obliges the king to conclude a peace.

48 Russia invaded with success.

49 Extraordinary military genius of the king.

invincible body of Finlanders, who had afterwards a very considerable share in the victories of Sweden.

Peace was no sooner concluded with Russia, than Gustavus was crowned with great solemnity at Upsal. Soon after this he ordered his general La Gardie to acquaint the Polish commander Codekowitz, that as the truce between the two kingdoms, which had been concluded for two years, was now expired, he desired to be certainly informed whether he was to expect peace or war from his master. In the mean time, having borrowed money of the Dutch for the redemption of a town from Denmark, he had an interview on the frontiers with Christiern the king of that country. At this interview, the two monarchs conceived the utmost esteem and friendship for each other; and Gustavus obtained a promise, that Christiern would not assist Sigismund in any design he might have against Sweden. In the mean time, receiving no satisfactory answer from Poland, Gustavus began to prepare for war. Sigismund entered into a negociation, and made some pretended concessions, with a view to seize Gustavus by treachery; but the latter having intimation of his design, the whole negociation was changed into reproaches and threats on the part of Gustavus.

50 Has a friendly interview with the king of Denmark, and prepares for war with Poland.

51 Marries Eleonora, daughter of the elector of Brandenburg.

Immediately after this, Gustavus made a tour in disguise through Germany, and married Eleonora the daughter of the elector of Brandenburg. He then resolved to enter heartily into a war with Poland; and with this view set sail for Riga with a great fleet, which carried 20,000 men. The place was well fortified, and defended by a body of veterans enthusiastically attached to Sigismund; but after a vigorous siege, the garrison being reduced to extremity, were obliged to capitulate, and were treated with great clemency.

52 Riga besieged and taken.

After the reduction of Riga, the Swedish monarch entered Courland, where he reduced Mittau; but ceded it again on the conclusion of a truce for one year. Sigismund, however, no sooner had time to recover himself, than he began to form new enterprises against the Swedes in Prussia; but Gustavus setting sail with his whole fleet for Dantzic, where the king of Poland then resided, so defeated his measures, that he was obliged to prolong the truce for another year. Sigismund, however, was not yet apprised of his danger, and refused to listen to any terms of accommodation: on which Gustavus entering Livonia, defeated the Polish general, and took Derpt, Hockenhausen, and several other places of less importance; after which, entering Lithuania, he took the city of Birsen.

53 The Poles defeated, and several places taken.

Notwithstanding this success, Gustavus proposed peace on the same equitable terms as before; but Sigismund was still infatuated with the hopes that, by means of the emperor of Germany, he should be able to conquer Sweden. Gustavus finding him inflexible, resolved to push his good fortune. His generals Horn and Thurn defeated the Poles in Semigallia. Gustavus himself with 150 ships set sail for Prussia, where he landed at Pillaw. This place was immediately delivered up to him; as were several other places. Sigismund, alarmed at the great progress of Gustavus, sent a body of forces to oppose him, and to prevent Dantzic from falling into his hands. In this he was attended with as little success as before; and in May 1627, Gustavus arrived with fresh forces before Dantzic, which he would probably have carried, had he not been wounded in the belly by a cannon-shot. The States of Holland sent ambassadors to mediate a peace between the two crowns; but Sigismund, depending on the assistance of the emperor of Germany and king of Spain, determined to hearken to no terms, and resolved to make a winter campaign. Gustavus, however, was so well intrenched, and all his forts were so strongly garrisoned, that the utmost efforts of the Poles were to no purpose. The city of Dantzic in the mean time made such a desperate resistance as greatly irritated Gustavus. In a sea engagement the Swedish fleet defeated that of the enemy; after which Gustavus, having blocked up the harbour with his fleet, pushed his advances on the land side with incredible vigour. He made a surprising march over a morass 15 miles broad, assisted by bridges of a peculiar construction, over which he carried a species of light cannon invented by himself. By this unexpected manœuvre he got the command of the city in such a manner, that the garrison were on the point of surrendering, when, by a sudden swell of the Vistula, the Swedish works were ruined, and the king was obliged to raise the siege. In other respects, however, the affairs of Gustavus went on with their usual good fortune. His general Wrangel defeated the Poles before Brodnitz. At Stum the king gained another and more considerable victory in person. The emperor had sent 5000 foot and 2000 horse under Arnheim, who joined the main army commanded by the Polish general Coniecspolski, in order to attack the Swedish army encamped at Quidzin. The enemy were so much superior in number, that the friends of Gustavus warmly dissuaded him from attacking them. But the king being determined, the engagement began. The Swedish cavalry charged with such impetuosity, contrary to their sovereign's express order, that they were almost surrounded by the enemy; but Gustavus, coming up to their assistance, pushed the enemy's infantry with so much vigour, that they gave way, and retreated to a bridge that had been thrown over the Werder. But here they were disappointed; for the Swedes had already taken possession of the bridge. On this a new action ensued more bloody than the former, in which the king was exposed to great danger, and thrice narrowly escaped being taken prisoner; but at last the Poles were totally defeated, with immense loss. The slaughter of the German auxiliaries was so great, that Arnheim scarcely carried off one half of the troops which he brought into the field. This defeat did not hinder the Polish general from attempting the siege of Stum; but here again he was attended by his usual bad fortune. Arnheim was recalled, and succeeded by Henry of Saxe Lawenburg and Philip Count Mansfeldt. The change of general officers, however, produced no good consequences to the Poles; a famine and plague raged in their camp, so that they were at last obliged to consent to a truce for six years, to expire in the month of June 1635. Gustavus kept the port and citadel of Memel, the harbour of Pillau, the town of Elbing, Brunsberg, and all that he had conquered in Livonia.

54 The Poles again defeated, and a great number of towns reduced by Gustavus.

55 The Poles defeated a third time. An. 1627.

56 The Poles defeated by sea, and Dantzic invested.

57 The king obliged by an inundation of the Vistula to raise the siege.

58 The Poles and Germans defeated with great slaughter in two engagements.

59 They are again defeated, and obliged to consent to a truce of six years.

60 Gustavus resolves on a war with the emperor.

Gustavus having thus brought the war with Poland to an honourable conclusion, began to think of resenting the conduct of the emperor in assisting his enemies and oppressing the Protestant states. Before embarking in such an important undertaking, it was necessary that he should consult the diet. In this the propriety of engaging

ging in a war with Germany was warmly debated; but, after much altercation, Gustavus in a very noble speech determined the matter, and set forth in such strong terms the virtuous motives by which he was actuated, that the whole assembly wept, and every thing was granted which he could require.

It was not difficult for Gustavus to begin his expedition. His troops amounted to 60,000 men, hardened by a succession of severe campaigns in Russia, Finland, Livonia, and Prussia. His fleet exceeded 70 sail, carrying from 20 to 40 guns, and manned with 6000 seamen. Embarking his troops, he landed at Usedom on

61 Reduces Wolgast, Stetin, &c. An. 1630.

the 24th of June 1630, the Imperialists having evacuated all the fortresses which they possessed there; and the isle of Rugen had been before reduced by General Lesly, in order to secure a retreat if fortune should prove unfavourable. Passing the frith, Gustavus stormed Wolgast and another strong fortress in the neighbourhood, leaving a garrison for the defence of these conquests. He then proceeded to Stetin; which consented to receive a Swedish garrison, and the king persuaded the duke of Pomerania to enter into an alliance with him. In consequence of this the Swedish troops were received into several towns of Pomerania; and the most bitter enmity took place between the Imperialists and Pomeranians.

These successes of Gustavus struck the empire with consternation; for being already overwhelmed with civil dissensions, they were in no condition to resist so impetuous an enemy.

62 Count Tilly chosen general by the emperor.

At last Count Tilly was invested with the dignity of veldt mareschal. In the mean time the king being reinforced by a considerable body of troops in Finland and Livonia under the conduct of Gustavus Horn, defeated the Imperialists before Griffenhagen; taking the place soon after by assault. By this and some other conquests he opened a passage into Lusatia and Silesia; but in the mean time Count Tilly

63 Cuts off 2000 Swedes.

cut off 2000 Swedes at New Brandenburg. This advantage, however, was soon overbalanced by the conquest of Franckfort on the Oder, which Gustavus took

64 Franckfort and Landberg taken by Gustavus.

by assault, making the whole garrison prisoners. Thus he commanded the rivers Elbe and Oder on both sides, and had a fair passage not only to the countries already mentioned, but also to Saxony and the hereditary dominions of the house of Austria. Soon after this, Gustavus laid siege to Landsberg, which he took by assault.

About this time the Protestant princes held a diet at Leipsic; to which Gustavus sent deputies, and conducted his negociations with such address, as tended greatly to promote his interests.

65 He reduces Pomerania, and restores the dukes of Mecklenburg.

Immediately after this he reduced Gripswald, and with it all Pomerania. Then marching to Gustrow, he restored the dukes of Mecklenburg to their dominions.

All this time Count Tilly was employed in the siege of Magdeburg; but now, being alarmed at the repeated successes of the Swedes, he left Pappenheim with part of the army before that city, while he marched with the rest into Thuringia, to attack the landgrave of

66 Magdeburg taken by the Imperialists, and the inhabitants cruelly used.

Hesse Cassel and the elector of Saxony. After a most obstinate defence, Magdeburg fell into the hands of Pappenheim, who committed there all imaginable cruelties. Gustavus formed a plan of recovering the city; but was obliged to abandon it, by Pappenheim's throwing himself into the place with his whole army, and by the progress which Tilly was making in Thuringia. Relinquishing this enterprise, therefore, he ordered an

67 Havelsberg and Werben reduced, and the cavalry of the Imperialists defeated by the Swedes.

attack on Havelsburg; which was done with such resolution, that the place was forced in a few hours, and all the garrison made prisoners. Werben was next obliged to submit after an obstinate conflict, in which many fell on both sides.—These successes obliged Count Tilly to attempt in person to check the progress of the Swedes. He detached the vanguard of his army, composed of the flower of the Imperial cavalry, within a few miles of the Swedish camp. An action ensued, in which Bernstein the Imperial general was defeated and killed, with 1500 of his men. Gustavus, after this advantage, placed himself in a situation so much superior to his enemies, that Count Tilly was fired with indignation, and marched up to the Swedish lines to give him battle. Gustavus kept within his works, and Tilly attacked his camp, though almost impregnably fortified, keeping up a most terrible fire from a battery of 32 pieces of cannon; which, however, produced no other effect, than obliging the Swedish monarch to draw up his army be-

68 Count Tilly defeated by Gustavus.

hind the walls of Werben. Tilly had placed his chief hopes in being able to spike the enemy's cannon, or set fire to their camp; after which he proposed making his grand attack. With this view he bribed some prisoners; but they betrayed him, and told his design to Gustavus. The king ordered fires to be lighted in different parts of his camp, and his soldiers to imitate the noise of a tumultuous disorderly rabble. This had the desired effect. The count led his army to the breach made by the cannon; where he was received with such a volley of grape shot as cut off the first line, and put the whole body in disorder, so that they could never be brought back to the charge. In this confusion the Imperial army was attacked, and after an obstinate conflict obliged to quit the field.

Soon after this action the queen arrived at the camp with a reinforcement of 8000 men; at the same time a

69 A body of British soldiers comes to the assistance of the Swedes.

treaty was concluded with Charles I. of England, by which that monarch allowed the marquis of Hamilton to raise 6000 men for the service of Gustavus. These auxiliaries were to be conducted to the main army by a body of 4000 Swedes; and were in every thing to obey the king while he was personally present, but in his absence were to be subject to the orders of the marquis. With these troops the king had resolved to make a diversion in Bremen: but the marquis finding it impossible to effect a junction with the Swedish army, resolved, without debarking his troops, to steer his course for the Oder, and land at Usedom. Gustavus was very much displeased at finding his project thus disconcerted; but, making the best of the present circumstances, he commanded the British troops to act on the Oder instead of the Weser. The number of this little army was magnified exceedingly by report, insomuch that Count Tilly had some thoughts of marching against them with his whole force; but on the departure of the marquis for Silesia, he reinforced the army in that country with a large detachment, which was thought to contribute not a little to the defeat he soon after received.

Since the late action Gustavus had kept within his intrenchments, where his army was well provided with every thing. Tilly made several attempts to surprise or draw him to an engagement; but finding all his endeavours fruitless, he marched into Saxony, and laid siege to

Sweden. to Leipsic. This precipitate measure proved highly advantageous to the Swedish monarch. A treaty offensive and defensive was immediately concluded with Gustavus: and the elector willingly promised every thing that was required of him. Tilly, in the mean time, carried fire and sword into the electorate. At the head of an army of 44,000 veterans, he summoned the city of Leipsic to surrender; denouncing the same vengeance against it as had been executed on Madgeburg, in case of a refusal. By this the governor was so much intimidated, that he instantly submitted; and also surrendered the castle of Passenberg, which was in a condition to have stood out till the arrival of the Swedish army. The elector, enraged at the loss of these valuable places, ordered his army to join the Swedes with all expedition, and pressed the king so warmly to engage, that at last he yielded to his desire. On the 7th of September 1631, Gustavus led out his army in the finest order, the Swedes forming one column on the right, and the Saxons another on the left; each amounting to 15,000 men. Tilly drew up his men in one vast column, probably with a view of surrounding the flanks of the king's army. Gustavus led on his troops against that wing of the Imperialists commanded by Pappenheim, whom he drove back to a considerable distance. General Bannier in the mean time cut in pieces the troops of Holstein, and mortally wounded the duke who commanded them. Pappenheim led on his troops seven times to the charge, but was as often repulsed by the Swedes. Tilly all this while was engaged with the Saxons; but having at last driven them off the field, the whole strength of the Imperial army was turned against the Swedish left wing. The Swedes sustained the attack with the greatest firmness, until the king detached the centre to assist them. The imperialists then were no longer able to stand their ground; but gave way everywhere except in the centre, which was composed of 18 regiments of veterans accustomed to victory, and deemed invincible. They made incredible efforts to maintain their reputation; and, though swept off in great numbers by the Swedish artillery, never shrunk or fell into confusion. Four regiments, after their officers had been killed, formed themselves, and retired to the skirt of a wood. Tilly retired at the head of 600 men, and escaped by the coming on of the night. Seven thousand Imperialists lay dead on the field of battle; 4000 were taken prisoners; a fine train of artillery was lost, with upwards of 100 standards, ensigns, and other military trophies.

70 Saxony ravaged by Count Tilly, who takes Leipsic.

71 Battle of Leipsic. An. 1631.

72 The Imperialist defeated with great slaughter.

Gustavus now determined to penetrate into Franconia, where he reduced several places, especially the fortress of Workburg. Tilly having collected his scattered troops, which formed an army still superior in number to that of Gustavus, marched to the relief of this place; but came too late. He then directed his march towards Rottenberg, where four regiments were cut in pieces by a Swedish detachment. After this the king reduced Hanau, Frankfort on the Maine, and Mentz; destroying a body of Spaniards, who had attempted to obstruct his passage.

73 The Swedes take a number of towns, and cut off four regiments of the enemy.

The court of Vienna was now thrown into the utmost confusion; and sent everywhere begging assistance, and soliciting the Catholic princes to arm in defence of their religion. The emperor was most embarrassed in finding out a general capable of opposing Gustavus in the field; for the late misfortunes of Count Tilly had entirely sunk his reputation. Wallestein, an old experienced officer, was selected; but as he had formerly been disgraced, it was apprehended that he would not accept of the command of which he had once been deprived. This objection, however, was got ever; and Wallestein not only accepted of the command, but, at his own expence, augmented the army to 40,000 men.

74 Wallestein chosen general by the emperor.

During the whole winter the Swedish army kept the field; and before the approach of summer had reduced a great number of places, while the landgrave William made great progress in Westphalia. Gustavus Horn was repulsed before Bamberg; but soon had his revenge, by entirely destroying two regiments of Imperialists. To prevent the troops from being affected by the loss before Bamberg the king resolved to give battle to Tilly, who was marching into Bavaria to prevent the Swedes from gaining a footing in that electorate. He pursued the Imperial general through a vast tract of country, defeated his rear-guard, and, having reduced a variety of towns and fortresses on the Danube, penetrated as far as Ulm. Advancing to the river Leck, Count Tilly posted himself in a wood on the opposite side, to dispute his passage. Gustavus endeavoured to dislodge him by a regular fire from 70 pieces of cannon. The slaughter was dreadful; and Tilly himself, being wounded by a cannon ball in the knee, died a few days before he was to have been superseded by Wallestein. The following night the Imperial army evacuated the post. Gustavus immediately crossed the river, and seized the towns of Rain and Newburg, which the enemy had abandoned, and Augsburg next submitted.

75 A great number of towns taken by the Swedes.

76 Count Tilly defeated and killed.

From Augsburg the Swedes advanced towards Ratisbon; but were disappointed in their design of getting possession of that city, as the Bavarians had thrown a numerous garrison into the place.—In the mean time, ambassadors arrived from Denmark, offering the mediation of that crown for obtaining a lasting peace between the contending parties. This negociation, however, failed of success, as the ambassadors had not been instructed to offer terms favourable to the Protestants. Gustavus now resolving to retort on themselves the cruelties which the Bavarians had inflicted on the Protestants, laid the towns of Morzbourg, Friesengen, and Landshut, in ashes. The inhabitants of Munich saved themselves by submission; Gustavus also defeated the forces of the elector, who had been joined by a considerable body of militia.

77 Three towns laid in ashes by the Swedes.

While Gustavus was thus employed, Wallestein had assembled a vast army. He was strongly solicited by the elector of Bavaria to come to his assistance; but, in revenge of the elector's having formerly obtained the command for Count Tilly in preference to himself, he drew off towards Bohemia to encounter the Saxons. Arnheim, who commanded the Saxon forces in that place, was an enemy to Gustavus, who had formerly rallied him for his cowardice. He therefore permitted Wallestein to gain an easy victory, in hopes that his master, the elector of Saxony, a prince entirely devoted to his pleasures, might be induced to relinquish the friendship of such a restless and warlike ally as Gustavus; and indeed he used all the eloquence of which he was master to detach him from the Swedish cause. Several advantages in the mean time, were gained by the Imperialists. Pappenheim defeated the archbishop of Bremen's cavalry at Werden; and three Swedish regiments were

78 The Saxon troops defeated by Wallestein.

were cut off near Kadingen. Pappenheim, however, was forced to retire, and withdraw his forces from Stade; of which the Swedes took possession. Wallestein and the elector of Bavaria, who had now joined their forces, threatened Gustavus with greatly superior numbers. At last, however, the king, being reinforced with 15,000 men, no longer declined the engagement; but Wallestein was too wise to trust the fate of the empire to a single battle against such an enemy as the king of Sweden.

79 Gustavus attacks his camp, and is repulsed with loss.

Gustavus attacked his camp, but was repulsed with the loss of 2000 men. Several other misfortunes happened to the Swedes; and at last, after various manœuvres, Wallestein bent his course towards Misnia, in order to oblige the elector of Saxony to declare against the Swedes, and to draw them out of Bavaria. Gustavus, notwithstanding the inconstancy of Augustus, immediately set out to assist him. With incredible diligence he marched to Misnia, where the Imperialists were assembling their whole strength. Hearing that the enemy were encamped at Wesenfells, and that Pappenheim had been detached with a strong corps, Gustavus resolved to engage them before they could effect a

80 Battle of Lutzen.

junction. With this view he marched to Lutzen, where he attacked Wallestein with incredible fury. The Swedish infantry broke the Imperialists in spite of their utmost efforts, and took all their artillery. The cavalry not being able to pass the river so expeditiously as the king thought necessary, he led the way, attended only by a single regiment and the duke of Saxe Lauwenburg.

81 Gustavus killed.

Here, after charging impetuously, he was killed. The news of his death was in an instant spread over both armies. The courage of the Imperialists revived, and they now made themselves sure of victory. But the Swedes, eager to revenge the death of their beloved monarch, charged with such fury that nothing could resist them. The Imperialists were defeated a second time, just as

82 The Imperialists totally defeated.

Pappenheim, with his fresh corps, came up to their assistance. On this the battle was renewed, but the Swedes were still irresistible. Pappenheim was mortally wounded, and his army finally routed, with the loss of 9000 killed in the field and in the pursuit.

83 Christina, an infant, proclaimed queen of Sweden.

This victory proved more unfortunate to Sweden than the greatest defeat. The crown devolved on Christina the daughter of Gustavus, an infant of six years old; the nation was engaged in an expensive foreign war, without any person equal to the arduous task of commanding the armies, or regulating domestic affairs, as Gustavus had done. Christina was immediately proclaimed queen. The regency devolved on the grand bailiff, the marischal, the high admiral, the chancellor, and the treasurer of the crown. Oxenstiern was invested with the chief management of affairs, and conducted himself with the greatest prudence. The reign and character of Christina have been fully detailed under the article CHRISTINA, to which we may refer our readers.

84 Charles Gustavus appointed heir to the crown of Sweden.

From the treaty of Westphalia, Sweden enjoyed some years of repose. Charles Gustavus, Count Palatine, having gained the favour of Christina, was appointed generalissimo of the forces, and heir-apparent to the crown. A marriage was proposed between them; but the queen would never listen to this or any other proposal of the kind. In 1650, the ceremony of the queen's coronation was performed; but in four years after, she

An. 1654.

resigned the crown in favour of Gustavus. (See the article CHRISTINA).

85 State of Sweden on the accession of Charles X.

The new king found himself involved in considerable difficulties on his accession to the throne. The treasury was quite exhausted; great part of the revenue was appointed for the support of Christina's household; the people were oppressed with taxes; and the nation having been disarmed for several years, began to lose its reputation among foreigners. To remedy these evils, Charles proposed to resume all the crown-lands which had been alienated by grants to favourites during the late reign; to repeal a duty which had been laid on salt; to put the kingdom in a posture of defence; and to enter on a war

86 War with Poland resolved on.

with some neighbouring state. Under a pretence that Casimir king of Poland had questioned his title to the throne, he prepared to invade that kingdom. Several embassies were sent from Poland to Stockholm; but some point of ceremony always disappointed them of an audience of the king; so that they were obliged to return without their errand. As soon as matters were in readiness, General Wittemberg made an irruption into Poland from the side of Pomerania. The Poles opposed him with an army of 15,000 men; but instead of fighting, they began to negociate, and in a short time entirely dispersed. Charles himself soon followed with a powerful army, and pursued his march without obstruction, all the cities throwing open their gates to him as he approached. As he advanced to Cracow, Casimir

87 The Poles defeated, and the kingdom reduced.

resolved to make one effort to save his capital. His army amounted only to 10,000 men; and these were unfortunately such as had never stood fire. After a feeble resistance, they fled with precipitation, having lost 1000 men killed and taken prisoners. A few days after this Charles defeated the Poles a second time, about eight leagues from Cracow; on which Casimir fled with his family to Oppelen in Silesia. The capital was then invested; and though defended with the utmost valour, was in a short time obliged to capitulate. Thus in less than three months Charles apparently became master of Poland; but it was soon evident that the Poles had no intention of abandoning their former sovereign.

88 War with the elector of Brandenburg. An. 1656.

In 1656, a war took place with the elector of Brandenburg. While Charles was employed in the conquest of Poland, that prince had invaded Royal and Ducal Prussia, and reduced the most considerable towns with little opposition. The king of Sweden took umbrage at his progress; and having marched against him, defeated his forces in several slight encounters, and obliged him to acknowledge himself a vassal of Sweden. These rapid conquests alarmed all Europe; and the different powers sought for means of driving the Swedes out of Poland, which they had so unexpectedly and unjustly seized.

89 The Poles revolt.

The Poles were no sooner assured that they should be assisted, than they every where revolted and massacred the Swedes. Casimir returned from Silesia; and those very troops and generals who had before submitted to Charles without opposition, now ranged

90 Charles gains a victory, but is obliged to retire.

themselves under the banners of his antagonist. Charles immediately marched from Prussia to chastise the insolence of the Poles, and totally defeated a body of 12,000 men. This did not hinder all the Poles incorporated with his troops to desert; which considerably reduced his army; and the campaign being performed in the depth of winter, he was at last obliged to retreat to Prussia. In his march he was harassed by the Poles; and a body of 4000 Swedes was surprised and defeated by them at Warka. This loss, however, was soon after

Sweden

recompensed by a complete victory gained by Adolphus the king's brother and General Wrangel. In the mean time the king was taking measures for laying siege to Dantzic; but was prevented by the Dutch, who threat-

91 Concludes a treaty with the Dutch and the elector of Brandenburg.

ened to oppose him, unless a proper regard was paid to their interest. Charles accordingly granted them advantageous terms; and afterwards gained over the elector of Brandenburg, by ceding to him the sovereignty of Prussia, that he might be at liberty to turn his whole strength against Poland.

By the treaty just concluded with the elector, the latter was to assist Charles in his war with Poland; but the elector had so procrastinated matters, that the Poles, having obtained assistance from the Tartars, had reduced the city of Warsaw. The two princes, however, now marched in concert against their enemies, who were encamped in a strong situation in the neighbourhood of the city above mentioned, their camp being fronted by the Vistula. The Poles were driven from their en-

92 The Poles and Tartars defeated with great slaughter.

trenchments with prodigious slaughter. The Poles and Tartars then laboured to break the alliance; with which view they entered Ducal Prussia, and defeated the electoral army, taking many prisoners. The Swedes soon had their revenge. General Steinboek attacked the same Polish army at Philippowa, and overthrew it with such slaughter as obliged the Poles for that season to quit the field. A more formidable enemy than the Poles now began to make their appearance. The Russians invaded the provinces of Carelia, Ingermania, and

93 The Russians invade the Swedish dominions.

Livonia; while the elector of Brandenburg, began to waver in his fidelity. To preserve this only ally at such a critical juncture, Charles was obliged to give him more advantageous terms than those already mentioned; while the Russians were repulsed in the provinces of Carelia and Ingermania. But in Livonia they had better success. See Russia. For seven months, however, they battered the walls of Riga, without venturing to pass the ditch or storm the practicable breaches.

Charles, notwithstanding the number of his enemies, was now become so formidable by the valour and discipline of his troops, that whole armies often fled on his

An. 1657.

approach. At last, in 1657, the Poles, finding they could not resist him in the field, contented themselves

94 Charles enters into an alliance with Ragotski prince of Transylvania.

with harassing the Swedes on their march, and cutting off the foragers and convoys. This proved much more destructive to the Swedes than their former method; so that Charles was obliged to enter into an alliance with Ragotski prince of Transylvania, by assigning him certain provinces in his neighbourhood, in order to furnish himself with irregular troops, who might fight the Poles in their own way. This, however, proved of no real advantage; for the confederates, after wasting a whole campaign in Lithuania, were obliged to return without accomplishing more than the reduction of a single for-

95 Leopold king of Hungary declares against Sweden.

tress; on which Charles returned with the Swedish army to Prussia.

Leopold, the young king of Hungary, having long beheld the Swedes with a jealous eye, now resolved to declare for Poland. The more effectually to curb the ambition of the Swedish monarch, he solicited the king

96 Ragotski's army destroyed by the Poles and Tartars.

of Denmark to come to a rupture with him. This was instantly complied with, and the Danes invaded Bremen. Charles hastened to oppose this new enemy; which gave such offence to Ragotski, that he neglected to take the proper measures for his own defence in the absence of the Swedes, and suffered his army to be destroyed by the Poles and Tartars. At the same time the Turks invaded Transylvania, under pretence that Ragotski, being a vassal of the Grand Signior, had no right to invade Poland without his leave. Ragotski opposed them in the field; where he was defeated and killed, leaving Charles destitute of the only ally on whom he could depend.

97 He is defeated and killed by the Turks.

The king, however, not dismayed by this misfortune, traversed Pomerania and the duchy of Mecklenburg; after which he attacked Holstein, while General Wrangel with another corps entered the duchy of Bremen. The latter executed his measures with the utmost vigour. In 15 days he retook all the towns which the enemy had reduced; defeated and drove the Danish army out of the country, killing 3000 of their best soldiers. In Holstein the king reduced several fortresses, laid Itzehoe in ashes, defeated a body of Danes, and laid siege to Frederic Udda, into which the Danes had thrown a strong garrison. The conduct of this siege he left to Wrangel, he himself retiring to Wismar in order to observe the situation of affairs in Poland; but no sooner was he gone than Wrangel attaked the place with such fury, that he became master of it in two hours. In the province of Halland the Swedes were defeated; but the enemy derived no advantage from their victory: at sea the fleets met, and maintained an engagement for two days, without any considerable advantage on either side. In Poland affairs were not better conducted. The house of Austria had now declared for Casimir; a German army entered Poland, and reduced Cracow, though not without great loss to themselves.

98 Bravery and success of General Wrangel.

99 The house of Austria declares against Sweden.

The king of Sweden was now surrounded by enemies. The elector of Brandenburg had declared against him; and he had besides to engage the armies of Austria, Poland, Russia, and Denmark. In this dangerous situation he resolved to attack Denmark, so as to oblige that power to come to a speedy accommodation. His designs were forwarded by a very early frost, which enabled him to transport his troops without shipping. Having passed over on the ice to the island of Funen, he cut in pieces a body of 4000 Danish soldiers and 500 peasants. The whole island was reduced in a few days; after which he passed to Langland, then to Laaland, after that to Falstre, and lastly to Zealand. The Danes were terrified at this unexpected invasion, and were giving themselves up to despair, when Charles offered to conclude a peace on equitable terms. The king of Denmark gladly consented; intending to renew the war as soon as he thought it could be done with safety.

100 Charles invades Denmark with great success.

101 Peace concluded. An. 1658.

Charles was no sooner retired, than the king of Denmark began to act secretly against him; on which, resolving to anticipate him in his designs, he appeared unexpectedly with a fleet before Copenhagen. The Swedish monarch laid siege to the capital, but with so little prudence that he made no progress, and was at length compelled to turn the siege into a blockade, which continued to the end of the war. Charles X. died of an epidemic fever, and was succeeded by his son Charles XI.

102 The war renewed, and Copenhagen besieged.

103 Charles XI. An. 1660.

The new king Charles XI. was a minor at the time of his father's death; and as the kingdom was involved in a dangerous war with so many enemies, the regency determined to conclude a peace, if it could be obtained on

Sweden.

on reasonable terms. A treaty was accordingly concluded at Olivia; by which Casimir renounced his pretensions to the crown of Poland, and that republic gave

104 Treaty of Olivia.

up all pretensions to Livonia. Bornholm and Drontheim were ceded to Denmark; and an equivalent in Schonen remained with Sweden. During the minority of the king, nothing remarkable occurs in the history of Sweden. In 1672 he entered into alliance with Louis

105 War with Brandenburg.

XIV. which two years after involved him in a war with the elector of Brandenburg. At first the Swedes carried all before them. Almost all the towns in Brandenburg were reduced, when the elector arrived with

106 The Swedes defeated by land and sea.

an army to the relief of his distressed subjects. He retook several towns, defeated the Swedes in a general engagement, and soon after forced them to abandon all their conquests. In conjunction with the Danes, he then invaded the Swedish dominions: many places of

An. 1676.

importance were reduced; and, in 1676, Sweden received a most destructive blow by the defeat of her fleet in an engagement with the combined fleets of Denmark and Holland. Soon after this the king took the government into his own hands, and in some degree restored the fortune of Sweden; but though matters went on in a more prosperous way where the king command-

107 Their affairs every-where go to wreck.

ed in person, the same losses and disgrace attended the Swedish arms in every other quarter. In 1678, the Swedish fleet was defeated in two engagements. At Landscroon a most obstinate battle was fought from ten in the morning till six at night; when both parties were obliged, by fatigue, to retire to their respective camps. At Oldeval in Norway, the Swedes were defeated; and the Danes laid desolate the islands of Oeland, Smaaland, Unno, and Kuno; while the electoral troops and Imperialists reduced Count Konigsmark to the utmost distress in the neighbourhood of Stralsund.

In this deplorable situation of affairs Count Konigsmark found an opportunity of attacking his enemies to such advantage, that he obtained a complete victory; after which he ravaged the duchy of Mecklenburg. Notwithstanding this success, he could not prevent the elector from reducing Stralsund; after which he was obliged to evacuate Pomerania; and, to complete his distress, the fleet which transported the Swedish army from Pomerania was wrecked on the coast of Bornholm.

In this unprosperous situation of affairs a peace was concluded at St Germain's between France and her enemies, by which the Swedes and Danes were left to decide their quarrel by themselves. Denmark was by no

108 Peace concluded.

means a match for Sweden, even in the distressed situation to which she was reduced; and therefore a treaty was concluded, on terms much more favourable to Sweden than could have been expected; and the peace was confirmed by a marriage between Charles and Ulrica Eleonora, daughter to the king of Denmark. From this time the Swedish monarch applied himself to the reformation of the state; and by artfully managing the disputes between the nobility and peasants, he ob-

109 Charles becomes absolute.

tained a decree empowering him to alter the constitution as he pleased. The proceedings of the king after this decree were such as to exasperate the nobility, and produce violent commotions. See PATKUL.

On the 15th of April 1697, died Charles XI. leaving his crown to his son, the celebrated Charles XII. at that time a minor. On his accession he found himself under the tuition of his grandmother Eleonora, who had governed the kingdom during the minority of the late

110 Charles XI. dies, and is succeeded by his son Charles XII.

king. Though Charles was at that time only 15 years of age, he showed a desire of taking the government into his own hands. His counsellors, Count Piper and Axel Sparre, signified his desire to the queen-regent. They were by her referred to the states; and there all

111 He takes the government into his own hands at the age of 15.

were unanimous: so that the queen, finding that opposition would be vain, resigned her power with a good grace; and Charles was invested with absolute authority, in three days after he had expressed his desire of reigning alone. He was scarcely seated on the throne when a powerful combination was formed against him. Augustus king of Poland formed designs on Livonia; the king

112 A powerful combination formed against him.

of Denmark revived the disputes he had with the duke of Holstein, as a prelude to a war with Sweden; and Peter the Great of Russia began to form designs on Ingria, formerly a province of Russia. In 1699 the king of Denmark marched an army into Holstein. Charles sent a considerable body of troops to the duke's assist-

113 Holstein ravaged by the Danes. An. 1699.

ance; but before their arrival the Danes had ravaged the country, taken the castle of Gottorp, and laid close siege to Tonningen. Here the king of Denmark commanded in person; and was assisted by the troops of Saxony, Brandenburg, Wolfenbuttle, and Hesse Cassel. England and Holland, as guarantees of the last treaty with Denmark, in concert with Sweden, joined Charles against this confederacy, and sent fleets to the Baltic. They proposed a termination of the war on equitable terms; but these were haughtily refused by the Danish monarch, who despised the youth and inexperience of Charles, and relied too much on the alliance he had formed with Saxony, Brandenburg, Poland, and Russia.

114 They are repulsed at Tonningen.

Tonningen, however, resisted all his efforts; and when he ordered the place to be stormed, he had the mortification to see his troops driven headlong from the walls by a handful of Swedes.

115 Charles sets out from Stockholm, and defeats the fleet of the allies. An. 1700.

In the year 1700, Charles, having entrusted the affairs of the nation with a council chosen out of the senate, set out on the 8th May from his capital, to which he never afterwards returned. He embarked at Carlscroon, and defeated the fleet of the allies. Having made a descent on the island of Zealand, he defeated a body of cavalry that opposed his march, and then proceeded to invest Copenhagen by sea and land. The king of Denmark then saw the necessity of either having his capital destroyed, or of doing justice to the duke of Holstein.

116 Obliges the Danes to make peace.

He chose the latter; and a treaty was concluded on much the same terms as formerly. Charles, being thus at liberty to turn his arms against the other princes who had conspired his destruction, resolved to lead his army

117 Marches against the Russians.

against Augustus king of Poland. On the road, however, he received intelligence that the tzar of Russia was on his march to oppose him, and had laid siege to Narva with an army of 100,000 men. The contest that ensued between Charles and Peter, with the celebrated battles of Narva and Pultava, have been already related under RUSSIA, so that we shall here confine ourselves chiefly to those events in which Peter the Great was not immediately concerned.

The tzar Peter was the chief support of Augustus, and he took the most active measures to oppose the progress of the Swedish monarch. His want of success, and the subsequent

Sweden. frequent contests between him and Charles, till the decisive battle of Pultava, are related in the article Russia.

118 Charles marches against the Saxons, An. 1701. In 1701, as early as the season permitted, Charles, having received a reinforcement from Sweden, took the field, and appeared suddenly on the banks of the Duna, along which the Saxon army was posted to receive him. The king of Poland being at that time sick, the army was commanded by Ferdinand duke of Courland, Marischal Stenau, and General Paykel, all officers of valour and experience. They had fortified certain islands in the mouth of the river, and taken every other precaution against an attack; the soldiers were hardy, well disciplined, and nearly equal to the Swedes in number;

119 and entirely defeats them. yet Charles, having passed the river in boats with high sides, to screen the men from the fire of the enemy, attacked them with such fury, that they were entirely defeated with great loss.

This victory was followed by the surrender of all the towns and fortresses in the duchy of Courland. Charles then passed into Lithuania, where every town opened its gates to him. At Birsen, an army of 20,000 Russians retired with the utmost precipitation on the news of his approach.

120 Forms a scheme for dethroning Augustus. Here Charles, perceiving that the kingdom of Poland was greatly disaffected to Augustus, began to project the scheme of dethroning him by means of his own subjects. This scheme he executed with more policy than he ever showed on any other occasion.

121 Makes a second application to no purpose. Augustus, in the mean time, finding his scheme of peace frustrated, had recourse to the senate; but met with such a rough answer from them, that he determined to apply to Charles. To him therefore he sent his

122 Warsaw taken. chamberlain; but a passport being forgotten, the ambassador was arrested. Charles continued his march to Warsaw, which surrendered on the first summons: but the citadel held out for some days. Augustus, finding at last that no dependence was to be placed on the Poles, determined to trust his fortune wholly to the Saxon army and the nobility of the palatinate of Cracow, who offered to support him to the utmost of their power. The Saxon army was now advanced to the frontiers, and Augustus immediately put himself at its head. Being joined by the nobility of Cracow, he found his forces to amount to 30,000 men, all brave and well disciplined. With these he marched in quest of his enemy; who did not

123 The Saxons entirely defeated. decline the combat, though he had with him only 12,000 men. Though the Saxons were strongly posted, having their front covered by a morass, besides being fortified

124 Cracow taken. with pallisadoes and chevaux de frise, they were attacked with irresistible impetuosity, and entirely defeated. This victory was followed by the loss of Cracow: after which Charles set out in pursuit of the flying army, with a design of preventing them from re-assembling; but his horse falling under him, he had the misfortune to break his thigh, by which he was confined six weeks; and thus Augustus obtained some respite. He improved this interval. Having convoked a diet first at Marienburg, and then at Lublin, he obtained the following resolutions; that an army of 50,000 men should be raised by the republic for the service of the prince; that six weeks should be allowed the Swedes to determine whether they were for war or peace; and that the same time should be granted to the turbulent and discontented nobles of Poland to make their concessions. To counteract the effects of these resolutions, Charles assembled another diet at Warsaw; and while the two assemblies disputed concerning their rights and privileges, he recovered from his wound, received a strong reinforcement from Pomerania, and utterly defeated and dispersed the remains of the Saxon army. Sweden. 125 Remains of the Saxon army entirely defeated.

The ill fortune of Augustus continued still to prevail. In 1704 he was formally deposed by the diet, and the crown conferred by Charles on Stanislaus Lecsinsky palatine of Posnania. An. 1704. 126 Augustus formally deposed, and Stanislaus raised to the throne. Augustus, however, did not yet tamely give up his kingdom. His adherents daily skirmished with the Swedes; and Augustus himself, being reinforced by 9000 Russians, retook Warsaw, and was near surprising the new king, who lived in perfect security in the city while Charles fought in his cause. Count Horn, with 1500 Swedes, vigorously defended the citadel; but at last, finding it no longer tenable, he was obliged to surrender at discretion. 127 Warsaw retaken by Augustus. The reduction of Warsaw was among the last advantages gained by Augustus in the course of this war. His troops were now composed of Saxon recruits and undisciplined Poles, who had no attachment to his person, and were ready on all occasions to forsake him. Charles and Stanislaus advanced with the victorious army; the Saxons fled before them, and the towns several miles round sent him their submissions. 128 Excellent conduct of his general Schullemberg. The Poles and Saxons were under the command of Schullemberg, a most sagacious and experienced general, who used every expedient to check the progress of the Swedes. With all his conduct and caution he found himself outwitted, and Charles in the neighbourhood of his camp ready to fall on him, while he thought him at 50 leagues distance. 129 His engagement with the Swedes. The Swedish monarch attacked him with a superior army, but entirely composed of horse. Schullemberg had posted his men in such a manner as rendered it impossible to surround them. His first rank being armed with pikes and fusees, presented a kind of rampart of bayonets; the second line stooping over the first who kneeled, fired over their heads, while the third rank, who stood upon their feet, kept up an incessant fire, by which the Swedish horse were exceedingly galled and put in disorder. Charles lost the opportunity of cutting off the whole Saxon army, by omitting to order his men to dismount. This was almost the first time that infantry had been regularly opposed to cavalry, and the superiority of the former was evident. 130 His fine retreat. After the engagement had continued about three hours, the Saxons retreated in good order; which no enemy had ever done before in any engagement with Charles. The Swedes pursued their enemies towards the Oder, and forced them to retreat through thick woods, almost impervious even to infantry. The Swedish horse, however, pushed their way, and at last inclosed Schullemberg between a wood and the river, where Charles had no doubt of obliging him to surrender at discretion, or die sword in hand, as having neither boats nor bridges; but the genius of Schullemberg supplied every defect. In the night he ordered planks and floats of trees to be fastened together; on which he carried over his troops, while the Swedes were employed in dislodging 300 men, whom he had placed in a windmill, for the purpose of defending his flank and keeping the enemy in play. Charles spoke of this retreat with admiration, and said he had been conquered by Schullemberg.

131 Augustus leaves Poland. No material advantage, however, resulted from this to Augustus; who was again obliged to leave Poland, and fortify

Sweden. fortify the capital of his hereditary dominions, which he expected every moment to see invested. In the mean

132 The Russians take several towns in Livonia, and invade Poland.

time the Russians having recovered their spirits, attacked the Swedes in Livonia with the utmost fury. Narva, Dorpt, and several other towns, were taken, and the inhabitants and garrisons treated with great barbarity. Soon after, an army of 100,000 Russians entered Poland. Sixty thousand Cossacks under Mazeppa entered the country at the same time, and ravaged every thing with the fury of barbarians. Schullenberg, too, perhaps more formidable than either, advanced with 14,000 Saxons and 7000 Russians, disciplined in Germany, and reputed excellent soldiers. Could numbers have determined the event of war, the Swedes must certainly have been at this time overpowered. Instead of this, however, Charles seemed to triumph over his enemies with more ease the more numerous they were. The Russians were defeated so fast, that they were all dispersed before

133 Astonishing success of Charles against them.

one party had notice of the misfortunes of another. The defeating an army of 40,000 men scarcely obstructed the march of the Swedes, while their astonished enemies looked on these actions as the effects of witchcraft, and imagined that the king of Sweden had dealings with infernal spirits. With these apprehensions they fled beyond the Dniepr, leaving the unhappy Augustus to his fate. Schullemberg, with all his skill and experience,

134 Schullemberg entirely defeated by Renschild.

succeeded no better. The Swedish general Renschild engaged and defeated him in half an hour, though the Swedes were vastly inferior in number, and their enemies posted in a most advantageous situation. Nothing could be more complete than this victory. This extraordinary victory, indeed, is said to have been owing to a panic which seized the troops of Schullemberg: but it was regarded with admiration, and thought to make the renown of Renschild equal to that of his sovereign. Charles himself was jealous, and could not help exclaiming, "Surely Renschild will not compare himself with me!"

135 Charles invades Saxony.

Soon after this victory, which was gained on the 12th of February, 1706, Charles entered Saxony at the head of 24,000 men. The diet at Ratisbon declared him an enemy to the empire if he crossed the Oder. But to this declaration no regard was paid. Charles pursued his march; while Augustus was reduced to the condition of a vagrant in Poland, where he possessed not a single town except Cracow. Into this city he threw himself with a few Saxon, Polish, and Russian regiments, and began to erect some fortifications for its defence; but the approach of the Swedish general Meyerfeldt, and the news of the invasion of Saxony, disconcerted all his measures, and threw him into despair. The Russians indeed were his faithful allies; but he dreaded them al-

136 Augustus begs for peace on any terms.

most as much as the Swedes: so that he was reduced to the necessity of writing a letter to Charles with his own hand, begging for peace on whatever terms he thought proper to grant. However, as he was then at the mercy of the Russians, this transaction was concealed with the greatest care. His emissaries were introduced to the Swedish court in the night-time; and being presented

137 Charles's answer.

to Charles, received the following answer: That King Augustus should for ever renounce the crown of Poland, acknowledge Stanislaus, and promise never to reascend the throne, should an opportunity offer; that he should release the princes Sobieski, and all the Swedish prisoners made in the course of the war; surrender Patkul, at that time resident at his court as ambassador for the tzar of Russia, and stop proceedings against all who had passed from his into the Swedish service. These articles, Charles wrote with his own hand, and delivered to Count Piper, ordering him to finish them with the Saxon ambassadors.

After his defeat at Pultava by the Russians, Charles fled in a mean calash, attended by a little troop inviolably attached to his person, some on foot, and some on horseback. They were obliged to cross a sandy desert, where neither herb nor tree was to be seen, and where the burning heat and want of water were more intolerable than the extremities of cold they had formerly suffered. The whole had almost perished for

138 Charles arrives in Turkey after his defeat at Pultava.

want of water, when a spring was fortunately discovered; after which they reached Otchakoff, a town in the Turkish dominions, the bashaw of which supplied the king with every necessary. It was some time, however, before boats could be got ready for transporting the whole of the king's attendants; by which accident 500 Swedes and Cossacks fell into the hands of the enemy. This loss affected him more than all his other misfortunes. He shed tears at seeing, across the river Bog, the greater part of his few remaining friends carried into captivity, without having it in his power to assist them. The bashaw waited on him to apologise for the delay, and was severely reprimanded by Charles, as if he had been his own subject.

The king remained but a few days at Otchakoff, when the serasquier of Bender sent an aga to compliment him on his arrival in the Turkish dominions, and

139 Is kindly received, and his hopes of conquering Russia begin to revive.

to invite him to that city. Here he was treated with hospitality: the Turks practised to its full extent their generous maxim of regarding as sacred the persons of unfortunate princes who had taken shelter in their dominions: and perhaps regarded him, notwithstanding his misfortunes, as an ally that might be useful to themselves against the Russians. Every one, indeed, regarded him in his distress. The French king offered him a safe passage from the Levant to Marseilles, from whence he might easily return to his own dominions. But Charles was too obstinate to receive advice. Puffed up with the notion of imitating Alexander the Great, he disdained to return except at the head of a numerous army; and he yet expected, by means of the Turks, to dethrone his adversary the tzar. Negociations for this purpose were carried on in the Turkish divan; and it was proposed to escort Charles with a numerous army to the frontiers of Poland: but the revolution which took

140 Augustus recovers the kingdom of Poland.

place there, put an end to all such projects. Augustus thought himself no longer bound to observe the treaty which he had made, than while Charles was at hand to compel him. After the battle of Pultava, he entered Poland, and took every measure, in concert with the tzar, for the recovery of his kingdom. Stanislaus was not able to stand before such enemies, but was obliged to leave his dominions and fly to Bender, in the disguise of a Swedish officer, in order to share the fortune of Charles.—It was not in Poland alone that the Swedish affairs began to suffer in consequence of the defeat at

141 The Danes invade Sweden;

Pultava. The Danes invaded the province of Schonen with an army of 13,000 foot and 2500 horse. Only 13,000 Swedish forces remained to defend all the territories possessed by Charles in Germany; and of these only a small part was allotted for the defence of Schonen.

nen. The regency of Sweden, however, exerted themselves to the utmost to repel this ungenerous invasion; and having collected an army of 12,000 militia and 8000 regulars, dispatched them under General Steenboek into Schonen. Some Saxon troops were incorporated in this army; and among these a prodigious desertion took place, which the general found it impossible to prevent; and thus the Danes gained several advantages, and at last took Christianstadt. Their insolence on this success was so great, that the Swedes demanded to be instantly led against them. Here the good fortune of Sweden seemed once more to revive. The Danes were driven from a very strong situation, with the loss of 8000 killed and taken prisoners, besides a vast number wounded. The king received the intelligence of this victory with the greatest exultation; and could not help exclaiming, "My brave Swedes, should it please God that I once more join you, we shall conquer them all!"

142 but are utterly defeated.

In the mean time, Charles, by means of his agents the count Poniatoffski and the sieur Neugebar, used his utmost efforts to procure a rupture between the Porte and Russia. For a long time the money bestowed by Peter on the vizirs and janisaries prevailed; but at last, in 1711, the grand signior, influenced by his mother, who was strongly in the interest of Charles, and had been used to call him *her lion*, determined to support his quarrel with Peter. He therefore gave orders to the vizir to fall on the Russians with an army of 200,000 men. The vizir promised obedience; but at the same time professed his ignorance in the art of war, and dislike to the present expedition. The khan of Crim Tartary, who had been gained over by the reputation and presents of the king of Sweden, had orders to take the field with 40,000 of his men, and had the liberty of assembling his army at Bender, that Charles might see that the war was undertaken on his account. See Russia, N° 119.

143 The Turks declare war against the Russians.

The treaty of the Pruth was most violently opposed by Count Poniatoffski and the khan of Tartary. The former had made the king acquainted with the situation of both armies; on which he instantly set out from Bender, filled with the hopes of fighting the Russians, and taking ample vengeance. Having ridden 50 leagues post, he arrived at the camp just as the tzar was drawing off his half-famished troops. He alighted at Poniatoffski's tent; and being informed of particulars, instantly flew in a rage to the vizir, whom he loaded with reproaches, and accused of treachery. Recollecting himself, however, he proposed a method by which the fault might be remedied; but finding his proposal rejected, he posted back to Bender, after having by the grossest insults showed his contempt of the vizir.

The violent behaviour of Charles did not promote his interest. The vizir perceived that his stay in Turkey might prove fatal to himself; and therefore determined to get him out of the country as soon as possible. Succeeding vizirs adopted the same plan; and at last the grand signior himself wrote a letter to Charles, in which he desired him to depart by next winter, promising to supply him with a sufficient guard, with money, and every thing else necessary for his journey. Charles gave an evasive answer, and determined to procrastinate his journey, as well to gratify his own stubborn temper, as because he discovered a correspondence between Augustus and the khan of Tartary, the object of which, he had reason to believe, was to betray him to the Saxons. When he was again pressed to fix the day of his departure, he replied, that he could not think of going before his debts were paid. Being asked how much was necessary for this purpose, he replied 1000 purses (A). Twelve hundred purses were instantly sent to the serasquier at Bender, with orders to deliver them to the king of Sweden, but not before he should have begun his journey. By fair promises, Charles persuaded him to part with the money; after which, instead of setting out, he squandered away his treasure in presents and gratifications, and then demanded 1000 purses more before he would set out. The serasquier was astonished at this behaviour. He shed tears; and turning to the king, told him, that his head would be the forfeit of having obliged him with the money. The grand signior, on being acquainted with the shameful behaviour of Charles, flew into a rage, and called an extraordinary divan, where he himself spoke, a thing very unusual for the Turkish monarchs. It was unanimously agreed that such a troublesome guest ought to be removed by force, should other means fail. Positive orders were therefore sent to Charles to depart; and, in case of refusal, to attack him in his quarters. Nothing could equal his obstinacy on this occasion: in spite of the menaces of his enemies, in spite of the intreaties of his friends, he persisted in his resolution; and at last determined to resist, with 300 Swedes, being all the attendants he had, an army of 20,000 janisaries well armed and furnished with cannon. At length he was attacked in good earnest; though it must be owned, that even in this extremity, the Turks showed their regard to him, and were tender of his life, which the king did not return at all in a similar manner. Most of the Swedes surrendered at once, perhaps as thinking it the only method of saving the king's life. This misconduct, however, had a quite contrary effect. Charles became the more obstinate, the more desperate his affairs seemed to be. With 40 menial servants only, and the generals Hord and Dardorff, he determined to defend himself to the last extremity. Seeing his soldiers lay down their arms, he told the generals, "We must now defend the house. Come, (adds he with a smile), let us fight *pro aris et focis*." The house had been already forced by the Tartars, all but a hall which was near the door, and where his domestics had assembled. Charles forced his way through the janisaries, attended by the generals Hord and Dardorff, joined his people, and then barricaded the door. The moment he entered, the enemy who were in the house, threw down their booty, and endeavoured to escape at the windows. Charles pursued them from room to room with much bloodshed, and cleared the house in a few minutes. He then fired furiously from the windows, killed 200 of the Turks in a quarter of an hour, so that the bashaw who commanded them was at length forced to set the house on fire. This

144 The grand signior desires him to depart.

145 Mean and unjust behaviour of Charles.

146 The Turks resolve to force him to depart.

147 His desperate resolution to resist.

148 Is abandoned by all his followers except 40.

149 Fights like a madman, but is taken prisoner with all his followers.

(A) Each purse contained 30 sequins.

This was done by arrows with lighted matches shot into the roof; but Charles, instead of quitting it, gave orders for extinguishing the fire, in which he himself assisted with great diligence. All efforts, however, were vain: the roof fell in; and Charles, with his few faithful companions, was ready to be buried in the ruins. In this extremity one called out, that there was a necessity for surrendering. "What a strange fellow! (cries the king), who would rather be a prisoner with the Turks than mix his ashes with those of his sovereign." Another had the presence of mind to cry out, that the chancery was but 50 paces off, had a stone roof, and was proof against fire. Pleased with the thoughts of again coming to blows, the king exclaimed, "A true Swede! Let us take all the powder and ball we can carry." He then put himself at the head of his troops, and sallied out with such fury, that the Turks retreated 50 paces; but falling down in the hurry, they rushed in upon him, and carried him by the legs and arms to the bashaw's tent.

This extraordinary adventure, which savours not a little of insanity, happened on the 12th of February 1713. He was now kept prisoner with all his retinue; and in this situation he was visited by the unfortunate Stanislaus.

150 Begins to think of returning to his dominions.

Charles at last seemed inclined to submit to his fate, and began seriously to think of returning to his kingdom, now reduced to the most deplorable situation. His habitation was now fixed at Demotica, a small town about six leagues from Adrianople. Here he was allowed provisions for his own table and those of his retinue; but only 25 crowns a-day in money, instead of 500 which he had received at Bender. During his residence here he received a deputation from Hesse Cassel, soliciting his consent to the marriage of the landgrave with Eleonora, princess royal of Sweden; to which he readily agreed: a deputation was also sent him by the regency of Sweden, requesting that he would prepare for returning to his own dominions, which were ready to sink under a ruinous war in his absence.

151 Sets out for Sweden. An. 1714.

On the 14th of October 1714, Charles set out for Sweden. All the princes through whose territories he was to pass, had given orders for his entertainment in the most magnificent manner; but the king, perceiving that these compliments only rendered his imprisonment and other misfortunes more conspicuous, suddenly dismissed his Turkish attendants, and assembling his own people, bid them take no care about him, but make the best of their way to Stralsund. After this he set out post, in the habit of a German officer, attended only by Colonel During. Keeping the bye-roads through Hungary, Moravia, Austria, Bavaria, Wirtemberg, the Palatinate, Westphalia, and Mecklenburgh, he arrived on the 21st of November at midnight before the gates of Stralsund. Being unknown, he was admitted with difficulty; but being soon recognised by the governor, the greatest tokens of joy were shown all over the town. In the midst of the tumult Charles went to bed.

152 Dismisses his retinue, and proceeds with only one attendant.

153 Arrives at Stralsund, and is received with the utmost joy.

154 Distressed situation of Sweden.

Sweden was now in the greatest distress. On the news of the defeat at Pultava, the Danes had invaded Schonen, but were defeated by General Steenboek. This vistory, however, did not put an end to the war. On the contrary, the kings of Denmark and Poland, with the tzar of Russia, entered into stricter bonds of amity than ever. They dreaded the return of Charles to his own dominions, and apprehended that numberless victories would soon efface the remembrance of Pultava. They determined, therefore, to make the best use of their time; and perhaps Charles never took a more imprudent resolution than obstinately to remain so long in the Turkish dominions. The return of Charles seemed to give new life to the whole nation. Though the number of inhabitants was visibly diminished, the levies he had ordered were completed in a few weeks: but the hands left to cultivate the earth consisted of the infirm, aged, and decrepid; so that a famine was threatened in consequence of the military rage which had seized all the youth of the kingdom.

155 The king is unable to retrieve the Swedish affairs. An. 1715.

The presence of Charles did not now produce those consequences which the allies had feared. The kingdom was too much reduced to furnish the necessary supplies of men and money; and though the king's courage and military skill were not in the least diminished, the efforts he made, instead of restoring Sweden to its splendour, served more completely to ruin it. In 1715, Prussia declared against him, on account of his demanding back the town of Stetin, which that monarch had seized. To complete his embarrassment, the elector of Hanover, George I. of Britain, also became his enemy.

156 Is encompassed on all sides by enemies.

The forces of Denmark, Prussia, Saxony, and Hanover, joined to invest Wismar, while a body of 36,000 men formed the siege of Stralsund; at the same time that the tzar, with a fleet of 20 large ships of war, and 150 transports, carrying 30,000 men, threw every part of the Swedish coast into the greatest consternation. The heroism of Charles could not prevail against so many enemies; yet he was still so much dreaded, that the prince of Anhalt, with 12,000 brave troops, did not think himself a match for this furious enemy when at the head of only 2000, till he had entrenched his army behind a ditch, defended by chevaux de frize. It appeared, indeed, that his precaution was not unnecessary: for in the night Charles with his men clambered up the ditch, and attacked the enemy in his usual manner. Numbers, however, at last prevailed; and Charles was obliged to retire, after having seen his favourite Grothusen, General Dardorff and During, the companions of his exile, killed by his side, he himself being wounded in the breast.

157 His desperate valour.

158 Stralsund besieged,

This rash attempt was made in order to save Rugen, whence the town of Stralsund was supplied with provisions. The place was well fortified, and garrisoned with 9000 men, with Charles himself at their head; but nothing could resist the efforts of the enemy. By the 17th of December it was proposed to give the assault. The attack on the horn-work was desperate: the enemy was twice repulsed; but at last, by dint of numbers, effected a lodgment. The next day, Charles headed a sally, in which he dealt terrible destruction among the besiegers, but was at length overpowered and obliged to retreat into the town. At last his officers, apprehending that he must either fall into the hands of the enemy, or be buried in the ruins of the place, intreated him to retire. A retreat, however, was now almost as dangerous as to remain in the town, on account of the fleets of the enemy with which the sea was covered; and it is thought that this very circumstance induced the king to consent to it. Setting out, therefore,

159 and taken, in spite of the utmost efforts of the king.

therefore, in a small boat with sails and oars, he passed all the enemy's ships and batteries, and arrived safe at Ystedt in Schonen.

160

Charles invades Norway to no purpose.

To revenge himself for these losses, Charles invaded Norway with an army of 25,000 men. The Danes were everywhere defeated and pursued with that vigour for which the king of Sweden was so remarkable; but strong reinforcements arriving from Denmark, and provisions failing, he was at last obliged to retire. Soon after this the Swedes lost Wismar; but when every thing seemed hopeless, Baron Goertz the chief minister and favourite of Charles contrived to set on foot a treaty with the tzar of Russia, by which the most formidable of all Charles's enemies was taken off. The minister found means to work on the inflexible temper of Charles, by representing to him that the cession of certain provinces to Peter would induce him to assist him in his projects of again dethroning Augustus, and of replacing James on the throne of Britain; which last scheme he had projected out of revenge for the elector of Hanover having seized on the duchies of Bremen and Verden. In consequence of the conferences between the tzar and Goertz, the former engaged to send into Poland an army of 80,000 men, in order to dethrone that prince whom he had so long defended. He engaged also to furnish ships for transporting 30,000 Swedes to Germany and 10,000 into Denmark. This treaty, however, was not ratified, and the king's death, which happened in 1718, put a final stop to all the great prospects of Sweden.

161

A treaty with the tzar of Muscovy projected.

162

Charles invades Norway again, and lays siege to Fredericks-hall.

The king had resolved on the conquest of Norway before he dethroned Augustus; and as no difficulties ever deterred him, he marched his army into that cold and barren country in the month of October, when the ground was covered with frost and snow. With 18,000 men he formed the siege of Frederickshall, though the severity of the frost rendered it almost impossible to break ground. Charles resolved to form trenches; and his soldiers cheerfully obeyed, digging into the ground with the same labour as if they had been piercing a rock. On the 11th of December the king visited the trenches in the midst of a terrible fire from the enemy, imagining that his men might be animated by his presence. He took his post in the most dangerous station he could choose, standing on a gabion and leaning with his arm over the parapet, while the enemy were firing chain shot at the very spot where he stood. He was intreated to change his station; but he remained obstinate. At last he was seen to fall on the parapet with a deep groan, and soon afterwards expired, having been mortally wounded, as is supposed, by a cannon ball. See CHARLES XII.

163

His extreme rashness, in consequence of which he is killed.

An. 1718.

164

Account of the Swedish affairs from the death of Chas. XII. to the year 1771.

Charles XII. was succeeded by his sister the princess Ulrica Eleonora, wife to the hereditary prince of Hesse. On this occasion the states took care to make a previous stipulation for the preservation of their liberties, and obliged the princess to sign a paper to this purpose before entering on the government. Their first care was to make a peace with Great Britain, which the late king intended to have invaded. The Swedes then, to prevent their farther losses by the progress of the Russian, the Danish, the Saxon, and other arms, made many great sacrifices to obtain peace from those powers. The French, however, about the year 1738, formed a dangerous party in the kingdom, which not only broke its internal quiet, but led it into a ruinous war with Russia, by which it lost the province of Finland. Their Swedish majesties having no children, it was necessary to settle the succession; especially as the duke of Holstein was descended from the queen's eldest sister, and was, at the same time, the presumptive heir to the empire of Russia. Four competitors appeared; the duke of Holstein Gottorp, Prince Frederic of Hesse-Cassel nephew to the king, the prince of Denmark, and the duke of Deux-Ponts. The duke of Holstein would have carried the election, had he not embraced the Greek religion, that he might mount the throne of Russia. The tzarina interposed, and offered to restore all the conquests she had made from Sweden, excepting a small district in Finland, if the Swedes would receive the duke of Holstein's uncle, Adolphus Frederic bishop of Lubec, as their hereditary prince and successor to their crown. This was agreed to; and a peace concluded at Abo, under the mediation of his Britannic majesty. This peace was so firmly adhered to by the empress of Russia, that his Danish majesty thought proper to drop all resentment for the indignity done his son. The prince-successor married the princess Ulrica, third sister to the king of Prussia; and in 1751 entered into the possession of his new dignity, which proved to him a crown of thorns. The French had acquired vast influence in all the deliberations of the Swedish senate, who of late had been little better than pensioners to that crown. The intrigues of the senators forced Adolphus to take part in the war against Prussia: but as that war was disagreeable not only to the people, but also to the king of Sweden, the nation never made so mean an appearance; and on Russia's making peace with the king of Prussia, the Swedes likewise made peace. Adolphus died dispirited in 1771, after a turbulent reign of twenty years; and was succeeded by his son Gustavus. The most remarkable transaction of this reign is the revolution which took place in the government in the year 1772, by which the king, from being the most limited became one of the most despotic monarchs in Europe. Ever since the death of Charles XII. the whole power of the kingdom had been lodged in the states; and this power they had much abused. Gustavus therefore determined either to seize on that power of which they made such a bad use, or perish in the attempt. The revolution was effected in the following manner. On the morning of the 19th of August 1772, a considerable number of officers, as well as other persons known to be attached to the royal cause, had been summoned to attend his majesty. Before ten he was on horseback, and visited the regiment of artillery. As he passed through the streets he was more than usually courteous to all he met, bowing familiarly to the lowest of the people. On the king's return to his palace, the detachment which was to mount guard that day being drawn up together with that which was to be relieved, his majesty retired with the officers into the guard-room. He then addressed them with all that eloquence of which he is said to have been a perfect master; and after insinuating to them that his life was in danger, he exposed to them in the strongest colours the wretched state of the kingdom, the shackles in which it was held by means of foreign gold, and the dissensions and troubles arising from the same cause which had distracted the diet during the course of fourteen

An. 1751.

165

Accession of Adolphus Frederic.

166

Gustavus III. ascends the throne. An. 1771.

167

Account of the revolution 1772, by which he became despotic.

Sweden.

teen months. He assured them that his only design was to put an end to these disorders; to banish corruption, restore true liberty, and revive the ancient lustre of the Swedish name, which had been long tarnished by a venality as notorious as it was disgraceful. Then assuring them in the strongest terms that he disclaimed for ever all absolute power, or what the Swedes call *sovereignty*, he concluded with these words: "I am obliged to defend my own liberty and that of the kingdom, against the aristocracy which reigns. Will you be faithful to me, as your forefathers were to Gustavus Vasa and Gustavus Adolphus? I will then risk my life for your welfare and that of my country."

The officers, most of them young men, of whose attachment the king had been long secure, who did not thoroughly perhaps see into nature of his majesty's request, were allowed no time to reflect, immediately consented to every thing, and took an oath of fidelity to him.

168 Resolution of a Swedish officer.

Only three refused. One of these, Frederic Cederstrom, captain of a company of the guards, alleged he had already, and very lately, taken an oath to be faithful to the states, and consequently could not take that which his majesty then exacted of him. The king, looking at him sternly, answered, "Think of what you are doing." "I do, (replied Cederstrom); and what I think to day, I shall think to-morrow: and were I capable of breaking the oath by which I am already bound to the states, I should be likewise capable of breaking that which your majesty now requires me to take."

The king then ordered Cederstrom to deliver up his sword, and put him in arrest.

His majesty, however, apprehensive of the impression which the proper and resolute conduct of Cederstrom might make on the minds of the other officers, shortly afterwards softened his tone; and again addressing himself to Cederstrom, told him, that as a proof of the opinion he entertained of him, and the confidence he placed in him, he would return him his sword without insisting on his taking the oath, and would only desire his attendance that day. Cederstrom continued firm; he answered, that his majesty could place no confidence in him that day, and that he begged to be excused from the service.

While the king was shut up with the officers, Senator Ralling, to whom the command of the troops in the town had been given two days before, came to the door of the guard-room, and was told that he could not be admitted. The senator insisted on being present at the distribution of the orders, and sent to the king to desire it; but was answered, he must go to the senate, where his majesty would speak to him.

The officers then received their orders from the king; the first of which was, that the two regiments of guards and of artillery should be immediately assembled, and that a detachment of 36 grenadiers should be posted at the door of the council-chamber to prevent any of the senators from coming out.

But before the orders could be carried into execution, it was necessary that the king should address himself to the soldiers: men wholly unacquainted with his designs, and accustomed to pay obedience only to the orders of the senate, whom they had been taught to hold in the highest reverence.

As his majesty, followed by the officers, was advancing from the guard room to the parade for this purpose, some of them more cautious, or perhaps more timid than the rest, became, on a short reflection, apprehensive of the consequences of the measure in which they were engaged: they began to express their fears to the king, that unless some persons of greater weight and influence than themselves were to take a part in the same cause, he could scarcely hope to succeed in his enterprise. The king stopped a while, and appeared to hesitate. A serjeant of the guards overheard their discourse, and cried aloud,—"It shall succeed—Long live Gustavus!" His majesty immediately said, "Then I will venture;"—and stepping forward to the soldiers, he addressed them in terms nearly similar to those which he had expressed to the officers, and with the same success. They answered him with loud acclamations: one voice only said, No; but it was not attended to.

169 The king gains over the soldiers.

In the mean time some of the king's emissaries had spread a report about the town that the king was arrested. This drew the populace to the palace in great numbers, where they arrived as his majesty had concluded his harangue to the guards. They testified by reiterated shouts their joy at seeing him safe; a joy which promised the happiest conclusion to the business of the day.

170 Secures the senators, and becomes master of the whole power in the kingdom.

The senators were now immediately secured. They had from the window of the council-chamber beheld what was going forward on the parade before the palace; and, at a loss to know the meaning of the shouts they heard, were coming down to inquire into the cause of them, when 30 grenadiers, with their bayonets fixed, informed them it was his majesty's pleasure they should continue where they were. They began to talk in a high tone, but were answered only by having the door shut and locked on them.

The moment the secret committee heard that the senate was arrested, they separated of themselves, each individual providing for his own safety. The king then mounting his horse, followed by his officers with their swords drawn, a large body of soldiers, and numbers of the populace, went to the other quarters of the town where the soldiers he had ordered to be assembled were posted. He found them all equally willing to support his cause, and to take to him an oath of fidelity. As he passed through the streets, he declared to the people, that he only meant to defend them, and save his country; and that if they would not confide in him, he would lay down his sceptre, and surrender up his kingdom. So much was the king beloved, that the people (some of whom even fell down on their knees) with tears in their eyes implored his majesty not to abandon them.

171 Summons an assembly of the states;

The king proceeded in his course, and in less than an hour made himself master of all the military force in Stockholm. In the mean time the heralds, by proclamation in the several quarters of the city, summoned an assembly of the States for the ensuing morning, and declared all members traitors to their country who should not appear. Thither his majesty repaired in all the pomp of royalty, surrounded by his guards, and holding in his hand the silver sceptre of Gustavus Adolphus. In a very forcible speech, he lamented the unhappy state to which the country was reduced by the conduct of a party

Sweden.

party ready to sacrifice every thing to its ambition, and reproached the states with adapting their actions to the views of foreign courts, from which they received the wages of perfidy. "If any one dare contradict this, let him rise and speak."—Conviction, or fear, kept the assembly silent, and the secretary read the new form of government, which the king submitted to the approbation of the states. It consisted of fifty-seven articles; of which the five following were the chief.

172 which accepts a new form of government.

1. The king has the entire power of convoking and dissolving the assembly of the states as often as he thinks proper. 2. His majesty alone has the command of the army, fleet, and finances, and the disposal of all offices civil and military. 3. In case of an invasion, or of any pressing necessity, the king may impose taxes, without waiting for the assembly of the states. 4. The diet can deliberate on no other subjects than those proposed by the king. 5. The king shall not carry on an offensive war without the consent of the states. When all the articles were gone through, the king demanded if the states approved of them, and was answered by a general acclamation. He then dismissed all the senators from their employments, adding, that in a few days he would appoint others; and concluded this extraordinary scene by drawing out of his pocket a small book of psalms, from which, after taking off the crown, he gave out Te Deum. All the members very devoutly added their voices to his, and the hall resounded with thanksgiving.

173 The king makes a good use of his power.

The power thus obtained was employed by the king for the good of his subjects. He took care that the law should be administered with impartiality to the richest noble and the poorest peasant, making a severe example of such judges as were proved to have made justice venal. He gave particular attention and encouragement to commerce, was a liberal and enlightened patron of learning and science, and laboured strenuously to introduce into his kingdom the most valuable improvements in agriculture that had been made in foreign countries.

174 Reforms the army and navy.

But while thus active in promoting the arts of peace, he was not inattentive to those of war. The fleet, which he found decayed and feeble, he in a few years restored to a respectable footing, and, besides changing the regulations of the navy, he raised a new corps of sailors, and formed them to the service by continual exercise. The army, which, as well as the navy, had been neglected during the aristocracy, was next to be reformed. The king began by giving cloaks, tents, and new arms to all the regiments. Afterwards, under the direction of Field Marshal Count de Hessenstein, a new exercise was introduced, and several camps were formed, in which the soldiery were manœuvred by the king himself. The sale of military offices, which had been permitted for many years, was entirely suppressed; and the king provided not only for the re-establishment of discipline and good order in the army, but for the future welfare of the individuals which composed it. These warlike preparations were necessary to a plan which he had formed for entirely abolishing the power of the aristocracy, and freeing Sweden from the factions which had long been formed in it by the court of St Petersburgh. The change which he had introduced was very inimical to the intrigues of that court; and the Russian ambassador exerted himself openly to bring about a rupture between the king and the discontented nobles. Gustavus ordered him to quit the kingdom in eight days, and immediately prepared for war with Russia. To this apparently rash enterprise he was incited by the Ottoman Porte, at that time unable to oppose the armies of the two empires; and his own ambition, together with the internal state of his kingdom, powerfully concurred to make him lend every assistance to his ancient ally. It is needless for us to enter into a detail of the particulars of that war, the principal circumstances of which have already been noticed under RUSSIA, N° 157. Suffice it to say, that neither Gustavus Adolphus nor Charles XII. gave greater proofs of undaunted courage and military conduct in their long and bloody wars than were given by Gustavus the III. from the end of the year 1787 to 1790, when peace was restored between the courts of St Petersburgh and Stockholm. When the court of Copenhagen was compelled, by the means of England and Prussia, to withdraw its troops from the territories of Sweden, the king attacked Russia with such vigour both by sea and land, displayed such address in retrieving his affairs when apparently reduced to the last extremity, and renewed his attacks with such pertinacious courage, that the empress lowered the haughtiness of her tone, and was glad to treat with Gustavus as an equal and independent sovereign.

175 His conduct in the war with Russia.

176 Produces a conspiracy against the king's life. An. 1792.

Sweden now enjoyed peace, but the nobles continued discontented, and a conspiracy was planned against Gustavus under his own roof. He had entered into the alliance that was formed against the revolutionary government of France; and to raise an army, which he was to lead in person to co-operate with the emperor and the king of Prussia, he was obliged to negociate large loans, and to impose on his subjects heavy taxes. The nobles took advantage of that circumstance to prejudice the minds of many of the people against the sovereign who had laboured so long for their good. On the 16th of March 1792 he received an anonymous letter, warning him of his immediate danger from a plot that was laid to take away his life, requesting him to remain at home, and avoid balls for a year; and assuring him that, if he should go to the masquerade for which he was preparing, he would be assassinated that very night. The king read the note with contempt, and at a late hour entered the ball room. After some time he sat down in a box with the compte d'Essen, and observed that he was not deceived in his contempt for the letter, since, had there been any design against his life, no time could be more favourable than that moment. He then mingled, without apprehension, among the crowd; and just as he was preparing to retire in company with the Prussian ambassador, he was surrounded by several persons in masks, one of whom fired a pistol at the back of the king, and lodged the contents in his body. A scene of dreadful confusion immediately ensued. The conspirators, amidst the general tumult and alarm, had time to retire to other parts of the room; but one of them had previously dropped his pistols and a dagger close by the wounded king. A general order was given to all the company to unmask, and the doors were immediately closed; but no person appeared with any particular distinguishing marks of guilt. The king was immediately conveyed to his apartment; and the surgeon, after extracting a ball and some slugs, gave favourable hopes of his recovery.

177 The king dangerously wounded.

178 Death of Gustavus III. An. 1792.

The favourable reports of his medical attendants soon appeared to be fallacious, and on the 28th of March a mortification

Sweden. mortification was found to have taken place. He expired on the following day, and on opening his body there were found within the ribs a square piece of lead and two rusty nails.

The king had by his will appointed a council of regency; but convinced by recent experience how little dependence was to be placed on the attachment of his nobles, and aware of the necessity of a vigorous government in times of such difficulty and danger, he appointed his brother, the duke of Sudermania, sole regent, till his son, then a minor, should attain the age of 18 years. In his dying moments he desired that all the conspirators, except the perpetrator of his murder, might be pardoned.

179 Accession of Gustavus IV.

The young king, who was about 14 at his father's death, was proclaimed by the name of Gustavus IV. The regent soon took the most vigorous and active measures to apprehend and punish the projectors and perpetrators of the murder of his brother. A nobleman of the name of Ankerstrom confessed himself the assassin, and gloried in the action, which he called liberating his country from a monster and a tyrant. He was executed in a most cruel manner on the 17th of May. Two other noblemen, and two officers, also suffered death; but the rest of the conspirators were either pardoned, or punished only by fine and imprisonment.

From the accession of Gustavus IV. till the revolution which has been recently effected in Sweden, few transactions of any importance have occurred. Soon after the king had taken on himself the administration of affairs, he engaged warmly in the war against France, and till the time of his deposition, continued a most faithful ally of Britain. The efforts of the Swedish monarch towards humbling the power of Bonaparte, have been already noticed under the articles BRITAIN and FRANCE; and the war with Russia, in which his alliance with Britain had involved him, has been sufficiently touched in the article RUSSIA. This prince seems to have been endowed with great and amiable qualities, but he was certainly rash and imprudent, and perhaps in some degree tinctured with insanity. He thus materially injured his kingdom, and alienated the affections of his principal nobles, especially of his uncle the duke of Sudermania.

180 Revolution in favour of the duke Sudermania. An. 1809.

In the beginning of March 1809, the plan which appears to have been concerted between the duke of Sudermania and the principal nobility, was carried into effect. The king was arrested; the duke assumed the reins of government, and issued a proclamation, announcing that under existing circumstances, the king was incapable of conducting the affairs of the nation.

Gustavus, now in close custody, was easily prevailed upon to abdicate the government. The diet was assembled; the duke of Sudermania was declared king of Sweden, under the title of Charles XIII.; Prince Augustenberg was chosen crown prince; and various changes were introduced into the constitution, confirming the powers of the diet, and doing away what the prevailing party held to be incroachments of the crown, during the late and preceding reigns. The people, wearied or disgusted by the late king's folly and rashness, readily acquiesced in all the alterations. Peace was then made with Russia, a measure become absolutely necessary, as the military force of the kingdom was completely broken, and no means existed to check the progress of the enemy. By this peace Sweden lost Finland, a country of peculiar importance to her on account of the supplies of grain she was accustomed to draw from it; but in the treaty she reserved the right of importing a certain quantity of grain yearly, duty free. Swedish Finland with Lapmark, now annexed to Russia, was estimated to contain about 120,000 square English miles, with 895,000 inhabitants. Peace was also concluded with France (6th January 1810), who gave up Pomerania.

Sweden was now enjoying tranquillity, when the sudden and unexpected death of the crown prince (Augustenberg) in April 1810, became a new source of perplexity. The duke of Sudermania was old and in a feeble state of health, and as there was no person within the kingdom who had any title by blood to the throne, it was necessary for the security of the new order of things to choose a successor. The threatening position which the acquisition of Finland gave to Russia, induced the noblemen who in concert with the court took a lead in this business, to look out for some man of military talents. It so happened that Bernadotte, prince of Ponte Corvo, who had lately commanded in the north of Germany, had gained the peculiar esteem of the Swedish officers and soldiers he had made prisoners in Gustavus's ill concerted operations in Pomerania, by his liberal and kind treatment. He was besides highly respected for his military skill; and had been still farther raised in general estimation, in consequence of Napoleon having removed him from his command for his lenity and humanity in exercising his power. Some of the Swedish officers, to whom his character was known, first conceived the idea of offering him the succession to the crown. The scheme was for some time kept extremely private; but received so much countenance from the most considerable men, that it was at length opened to Bernadotte himself in Paris. He received it as might be expected; and his friends redoubled their intrigues. The prince of Denmark had been proposed, but the ancient enmity against that country was an invincible obstacle to his success. At length, when every thing was prepared, the diet was called, and Bernadotte was elected crown prince, with acclamations, by all the four orders, on the 21st of July. Of all the changes in the fortune and station of individuals which arose out of the French revolution, this is perhaps the most singular. Bonaparte seized the royal power and dignity for himself, and by force of arms he compelled some of the weaker states to accept his relations and followers as kings. But it does not appear that he was ever consulted as to Bernadotte's elevation, or had the smallest influence in it, except that the example given in his own person and that of his followers, had contributed to destroy some of the old illusions as to birth and hereditary honours, and had prepared men's minds for great innovations. It was thus that the son of a French peasant was raised to the Swedish throne, by the spontaneous choice of a body of nobles, proud of their birth and ancestry.

The appearance of Bernadotte in the Swedish capital was followed by numerous feasts and spectacles. He received congratulations from all the public bodies; and though not immediately called to the throne, was, from the king's infirmities, entrusted with the entire conduct of the government. One of his first acts was to recommend to the diet the introduction of a conscription law like that of France, a measure which certainly hazarded his popularity. It passed however; and on this occasion he prevailed with the nobles, to make a voluntary surrender of their ancient privilege of exemption from military service, and from taxation. Pressed by France and Russia, Sweden in November 1810, professed her adherence to the continental system, and declared war against Britain. The war, however, was only nominal, and the British cruisers returned in most cases their captures untouched. This state of things continued till Bonaparte was preparing for his great Russian campaign, when the Swedish government, solicited by both parties, and tempted by great offers, at length signed treaties of alliance with Russia and Britain in 1812 and 1813. By these treaties, the two powers mentioned engaged to assist the king in conquering Norway from Denmark. The French, for the purpose of intimidation, had previously seized Pomerania. Bernadotte carried over an army of 30,000 Swedes to Germany in 1813, and being joined by several large bodies of Prussian and German troops, he was encountered by Marshal Ney between Berlin and Leipsic on the 6th September, and after an obstinate engagement, drove back the French army with the loss of 16,000 men. In the battle of Leipzic also, fought the 18th October, he bore a conspicuous share. After the victory, he continued to act against Marshal Davoust's corps, and against the Danes, till he made the latter to capitulate. He lost no time in improving this advantage; and by a treaty concluded at Kiel on the 14th January 1814, compelled Denmark to cede Norway, giving her the trifling possession of Pomerania in return. He now advanced to the Rhine; but satisfied with reducing Napoleon's power, and, from views of interest, most probably adverse to ruining him, he was thought to be rather dilatory in pushing his advantages. The success of the allies at length left him at liberty to secure Norway, the prize for which he had fought. As the Norwegians announced their intention to resist, he crossed the frontier with an army in July, and, by judicious manœuvres, which placed the Norwegian force in his power, he obliged them to capitulate, and obtained possession of the country almost without bloodshed; Norway preserving its ancient constitution, and having states of its own. On the death of Charles XIII. in 1818, Bernadotte mounted the throne; and, being on good terms with most of the surrounding powers, has every chance to preserve his situation, and transmit the crown to his posterity.

181 Government.

We have seen, that from the reign of Charles XII. to the revolution under Gustavus III. in 1772, the government of Sweden was a limited monarchy, and that since that time, till the accession of the present king (Charles XIII.) the power of the monarchs was absolute. In 1811, however, the power of the diet was re-established by new regulations. The four estates of nobles, clergy, burghers, and peasants, sit in separate houses, and meet necessarily at the end of five years, or oftener, if convoked by the king. The consent of three of these houses, with that of the king, gives a proposition the form of law. No taxes can be raised without the authority of the diet; and the persons of the members are inviolable during the session. The session lasts three months or longer. The law declares the press to be free; but this provision has not been enforced. The nobles consist of about 1200 families, the heads of which sit in the diet. (See James's Travels, 1817.)

182 Revenues.

The revenue of Sweden and Norway united, is estimated at no more than 1,500,000l. sterling since the peace in 1815. The debt of Sweden in 1816 was 10,209,611 dollars banco, or about 1,480,000l.; and Norway also owes a considerable sum.

183 Military strength.

The army, which amounted to 53,560 men in 1817, is chiefly supported by lands which are assigned to the soldiers to cultivate. The navy is stated to consist of 20 ships of the line, and 16 frigates. The conscription places all the young men from 20 to 25, who are estimated to amount to 80,000, at the disposal of the government for military duty.

184 Religion.

Christianity was introduced into Sweden in the 9th century. Their religion is Lutheran, which was propagated among them by Gustavus Vasa about the year 1523. The Swedes are surprisingly uniform and unremitting in religious matters; and have such an aversion to Popery, that if a Roman Catholic priest be discovered in the country, he is treated with the greatest indignity. The archbishop of Upsal had a revenue of 400l. a-year, and had under him 13 suffragans with moderate stipends. No clergyman had the least direction in the affairs of state. Their morals, and the sanctity of their lives, were such as to endear them to the people. Their churches are neat, and often ornamented. A body of ecclesiastical laws and canons direct their religious economy. A conversion to Popery, or a long continuance under excommunication, which cannot pass without the king's permission, was punishment and exile.

185 Language and literature.

The language of Sweden is a dialect of the Gothic, and nearly allied to those of Denmark, Norway, and Iceland. In the two grand divisions of the Gothic, consisting of the German and Scandinavian dialects, the latter is distinguished by greater brevity and force of expression. In the south of Sweden, which contains the chief mass of population, some German and French words have been adopted; while the Dalecarlian, in the north-west, is esteemed a peculiar dialect, perhaps only because it contains more of the ancient terms and idiom.

In the antiquity of literature, Sweden cannot pretend to vie with Denmark, Norway, or Iceland; the most nearly native chronicle, or perhaps literary composition, being not more ancient than the 14th century. In return, while the Danes seem occupied with internal policy and public regulation, the Swedes have, in modern times, borne the palm of genius in many departments of literature and philosophy.

But Swedish literature can scarcely be said to have dawned till the middle of the 17th century, when Queen Christina, finding the country immersed in ignorance, invited Grotius, Descartes, and other celebrated men, who though they did not reside long in the kingdom, sowed the seed of letters, which gradually began to prosper in the wise and beneficent reign of Charles XI. In the succeeding or 18th century, the name of Linné alone might distinguish the national literature; and it is joined in natural history with those of Scheele, Bergman, Tilas, Wallerius, Quist, Cronstedt, and others. In history, Dalin and Lagerbring have distinguished themselves by a precision and force, which the Danes seem to sacrifice to antiquarian discussions. Sweden also boasts of native poets and orators; and the progress of the sciences

Sweden. ences is supported by the institution of numerous academies.

186 Produce and agriculture. The Swedes, since the days of Charles XII. have been at incredible pains to correct the barrenness of their country, by encouraging agriculture. Wheat is raised only in the southern provinces; rye, oats, barley, and potatoes, are raised in the rest of the kingdom. The whole annual produce of grain, however, was estimated to amount only to 5,700,000 spans, or 1,482,000 quarters in 1810; a quantity not sufficient for the consumption of the country. Potatoes are in general use. The farms are commonly small, and the return of the crops is computed to be 5 for 1. For some years previous to 1812, there had been a progressive rise of prices, and agriculture had considerably improved. But since this period a revulsion seems to have taken place. The common people know, as yet, little of the cultivation of apricots, peaches, nectarines, pine-apples, and other high-flavoured fruits; but melons are brought to the greatest perfection in dry seasons.

187 Manufactures and commerce. The Swedish commonalty subsists by agriculture, mining, hunting, grazing, and fishing. Their materials for traffic are the bulky and useful commodities of masts, beams, and other kinds of timber for shipping; tar, pitch, bark of trees, potash, wooden utensils, hides, flax, hemp, peltry, furs, copper, lead, iron, cordage, and fish.

Even the manufacturing of iron was introduced into Sweden so late as the 16th century; for till then they sold their own crude ore to the Hanse towns, and bought it back again manufactured into utensils. About the middle of the 17th century they set up some manufactures of glass, starch, tin, woollen, silk, soap, leather-dressing, and saw mills. Bookselling was at that time unknown in Sweden. They have since had sugar making, tobacco plantations, and manufactures of sail cloth, cotton, fustian, and other stuffs; also of linen, alum, brimstone, paper mills, and gunpowder-mills. The iron mine of Dannemora is said to yield 60lbs. of metal in 100lbs. of ore, and others about 30lbs. The iron extracted from this is known in Europe by the name of *Oregrund*, which name is derived from a seaport on the Baltic. A large portion of it is employed by different nations for making the best steel. The wood of Sweden is highly valued for some purposes; and Norway has a very considerable trade in timber of various kinds. The Swedes have also founderies for cannon, manufactories for fire-arms and anchors, armories, wire and flatting mills, also mills for fulling, and for boring and stamping; and of late they have built many ships for sale.

According to the tables drawn up by Mr Coxe, the Swedish exports amounted, about 30 years ago, to 1,368,830l. while the imports amounted to 1,008,391l. In 1816 the exports were stated to be about seven millions of dollars (exclusive of Norway), and the imports twenty millions. This real or supposed inequality, accompanied by considerable commercial distress, created a great alarm in the country, and led the government to issue edicts of the nature of sumptuary laws. Wine, rum, and various manufactured articles were prohibited to be imported; and injunctions were issued to the people to lay aside the use of costly articles and every thing considered a luxury. We know not what the result has been, but the indubitable tendency of such measures is to increase the evils they are meant to cure. The imports are chiefly corn, hemp, tobacco, sugar, coffee, drugs, silk, wine, and brandy.

188 Character of the Swedes. The Swedish peasants seem to be a heavy plodding race of men, strong and hardy, but without any other ambition than that of subsisting themselves and their families as well as they can: they are honest, simple, and hospitable; and the mercantile classes are much of the same cast; but great application and perseverance is discovered among them all. The principal nobility and gentry of Sweden are naturally brave, polite, and hospitable; they have high and warm notions of honour, and are jealous of their national interests. The dress of the common people is almost the same with that of Denmark: the better sort are infatuated with French modes and fashions. The common diversions of the Swedes are skating, running races in sledges, and sailing in yachts upon the ice. The women go to plough, thresh out the corn, row upon the water, serve the bricklayers, carry burdens, and do all the common drudgeries in husbandry.

Swedenborg. SWEDENBORG, Emanuel, was born at Stockholm in Sweden, in January 1689. His father was bishop of West Gothland; member of a society for the propagation of the gospel, formed on the plan of that of England; and president of the Swedish church in Pennsylvania and London. To this last office he was appointed by Charles XII. who seems to have had a great regard for the bishop, and to have continued that regard to his son.

Of the course of young Swedenborg's education we have procured no account; but from the character of the father, it may be supposed to have been pious; and by his appearing with reputation as an author, when but 20 years of age, it is proved to have been successful. His first work was published in 1709; and the year following he sent into the world a collection of pieces on different subjects, in Latin verse, under the title of *Ludus Heliconius, sive Carmina Miscellanea quæ variis in locis cecinit.* The same year he began his travels,

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first into England, afterwards into Holland, France, and Germany; and returning to Stockholm in 1714, he was two years afterwards appointed to the office of assessor in the Metallic College by Charles XII. who honoured him with frequent conversations, and bestowed upon him a large share of his favour. At this period of his life Swedenborg devoted his attention principally to physic and mathematical studies; and in 1718 he accompanied the king to the siege of Fredrickshall, where he gave an eminent proof that he had not studied in vain. Charles could not send his heavy artillery to Frederickshall from the badness of the roads, which were then rendered much worse than usual by being deeply covered with snow. In this extremity Swedenborg brought the sciences to the aid of valour. By the help of proper instruments he cut through the mountains, and raised the valleys which separated Sweden from Norway, and then sent to his master two galleys, five large boats, and a sloop, loaded with battering pieces, Swedenborg. pieces, to be employed in the siege. The length of this canal was about two miles and a half. The execution of this great work, however, did not occupy all his time. In 1716 he had begun to publish essays and observations on the mathematical and physical sciences, under the title of *Dædalus Hyperboreus;* and he found leisure during the siege to complete his intended collection, and also in the same year to publish an introduction to algebra, under the whimsical title of *The Art of the Rules.*

At the siege of Frederickshall he lost his patron Charles; but found another in Ulrica Eleonora, the sister and successor of that hero, by whom in 1719 he was ennobled, and took of course his seat among the senators of the equestrian order in the triennial assemblies of the states. His promotion did not lessen his ardour for the sciences; for he published in the same year *A Method to fix the Value of Money, and to determine the Swedish Measures in such a way as to suppress all the Fractions and facilitate the Calculations.* About the same time he gave the public a treatise on *the Position and Course of the Planets;* with another on *the Height of the Tides, and Flux and Reflux of the Sea;* which, from information gathered in different parts of Sweden, appeared to have been greater formerly than when he wrote.

As Swedenborg continued, under the new sovereign, to hold the office of assessor to the Metallic College, he thought it necessary, for the discharge of his duty, to make a second journey into foreign countries, that he might himself examine their mines, particularly those of Saxony and Harts. During these travels, which were undertaken for the improvement of the manufactures of his native country, he printed at Amsterdam, 1. *Prodromus principiorum Naturalium, sive novorum tentaminum, Chemiam et Physicam experimentalem geometricè explicandi.* 2. *Nova observata et inventa circa Ferrum et Ignem, præcipue naturam Ignis Elementarum, una cum nova Camini inventione.* 3. *Methodus nova inveniendi Longitudines locorum terræ marique ope Lunæ.* 4. *Modus construendi receptacula navalia, vulgo en Suedois, Dockybynadder.* 5. *Nova constructio aggeris aquatici.* 6. *Modus explorandi virtutes Navigiorum.* And at Leipsic and Hamburg, 7. *Miscellanea observata circa res naturales, præsertim Mineralia, Ignem, et Montium strata.* (European Magazine, 1787, July.)

This journey was made, and these tracts published, in the compass of a year and a half; and perhaps there has not been another man, Linnæus excepted, who has done so much in so short a time. After his return in 1722, Swedenborg divided his time so equally between the duties of his office and his private studies, that in 1733 he finished his grand work, entitled *Opera Philosophica et Mineralia*, and had it printed under his own direction in 1734, part at Dresden and part at Leipsic; in which year he also went to inspect the mines of Austria and Hungary. This work is divided into three volumes folio; the title of the first is *Principia rerum Naturalium sive novorum tentaminum, Phænomena Mundi elementaris philosophicè explicandi.* The second, *Regnum Subterraneum sive Minerale de Ferro;* and the third, *Regnum Subterraneum sive Minerale de Cupro, et Orichalco;* all of them written with great strength of judgment, and ornamented with plates, to facilitate the comprehension of the text.

In the year 1729 he was enrolled among the members of the Society of Sciences at Upsal, and was, probably about the same time, made a Fellow of the Royal Academy of Sciences at Stockholm; nor were strangers less willing than his own countrymen to acknowledge the greatness of his merit. Wolfius, with many other learned foreigners, was eager to court his correspondence. The Academy of St Petersburg sent him, on the 17th of December 1734, a diploma of association as a correspondent member; and soon afterwards the editors of the *Acta Eruditorum* at Leipsic found in his works a valuable supplement to their own collection. Swedenborg.

By many persons the approbation of learned academies would have been highly valued; but by Baron Swedenborg it was considered as of very little importance. "Whatever of worldly honour and advantage may appear to be in the things before mentioned, I hold them (says he) but as matters of low estimation, when compared to the honour of that holy office to which the Lord himself hath called me, who was graciously pleased to manifest himself to me, his unworthy servant, in a personal appearance, in the year 1743, to open in me a sight of the spiritual world, and to enable me to converse with spirits and angels; and this privilege has continued with me to this day. From that time I began to print and publish various unknown *Arcana*, which have been either seen by me or revealed to me, concerning heaven and hell, the state of men after death, the true worship of God, the spiritual sense of the Scriptures, and many other important truths tending to salvation and true wisdom." (*Short Account of the Honourable E. Swedenborg.*)

We shall not affront the understandings of our readers by making upon this account of the Baron's *call* such reflections as every person of a sound mind will make for himself; but it is rather remarkable, that a man who had devoted the better part of his life to the study of such sciences as generally fortify the mind against the delusions of fanaticism, and who had even excelled in these sciences, should have fallen into such a reverie as this. After this extraordinary call, the Baron dedicated himself wholy to the great work which, he supposed, was assigned him, studying diligently the word of God, and from time to time publishing to his fellow-creatures such important information as was made known to him concerning another world. Among his various discoveries concerning the spiritual world, one is, that it exists not in space. "Of this (says he) I was convinced, because I could there see Africans and Indians very near me, although they are so many miles distant here on earth; nay, that I could be made present with the inhabitants of other planets in our system, and also with the inhabitants of planets that are in other worlds, and revolve about other suns. By virtue of such presence (i. e. without real space), not of place, I have conversed with apostles, departed popes, emperors, and kings; with the late reformers of the church, Luther, Calvin, and Melancthon, and with others from distant countries." (*Swedenborg's Universal Theology*, vol. i. p. 87.)

Notwithstanding the want of space in the spiritual world, he tells us, "that after death a man is so little changed that he even does not know but he is living in the present world; that he eats and drinks, and even enjoys conjugal delight as in this world; that the resemblance between the two worlds is so great, that in the spiritual world there are cities, with palaces and houses, (*Ibid.* N° 734.)

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houses, and also writings and books, employments and merchandises; that there is gold, silver, and precious stones there. In a word (he says), there is in the spiritual world all and every thing that there is in the natural world, but that in heaven such things are in an infinitely more perfect state."

Such was his zeal in the propagation of these whimsical and sometimes sensual doctrines, that he frequently left his native country to visit distant cities, particularly London and Amsterdam, where all his theological works were printed at a great expence, and with little prospect or probability of a reimbursement. "Where-ever he resided when on his travels, he was (says one of his admirers) a mere solitary, and almost inaccessible, though in his own country of a free and open behaviour. He affected no honour, but declined it; pursued no worldly interest, but spent his time in travelling and printing, in order to communicate instruction and benefit to mankind. He had nothing of the precise in his manner, nothing of melancholy in his temper, and nothing in the least bordering on enthusiasm in his conversation or writings." This is too much. We believe he was an inoffensive visionary; of his conversation we cannot judge; but the specimens that we have given of his writings are frantic enthusiasm. He died at London, March 29th, in the year 1772; and after lying in state, his remains were deposited in a vault at the Swedish church, near Radcliff-Highway.

Short Account, &c. p. 11. and *Harley's Preface to the Treatise on Influx.*

Though Baron Swedenborg's followers appear not to have been numerous during his life, they have increased since his death; and a sect subsists at present in England which derives its origin from him, and is called *the New Jerusalem Church*. The discriminating tenets of this sect seem to be the following: "Holding the doctrine of one God, they maintain that this one God is no other than Jesus Christ, and that he always existed in a human form; that for the sake of redeeming the world, he took upon himself a proper human or material body, but not a human soul; that this redemption consists in bringing the hells or evil spirits into subjection, and the heavens into order and regulation, and thereby preparing the way for a new spiritual church; that without such redemption no man could be saved, nor could the angels retain their state of integrity; that their redemption was effected by means of trials, temptations, or conflicts with evil spirits; and that the last of them, by which Christ glorified his humanity, perfecting the union of his divine with his human nature, was the passion of the cross. Though they maintain that there is but one God, and one divine person, they hold that in this person there is a real Trinity; consisting of the divinity, the humanity, and the operation of them both in the Lord Jesus; a Trinity which did not exist from all eternity, but commenced at the incarnation. They believe that the Scriptures are to be interpreted not only in a literal but in a spiritual sense, not known to the world till it was revealed to B. Swedenborg; and that this spiritual sense extends to every part of Scripture, except the Acts of the Apostles. They believe that there are angels attending upon men, residing, as B. Swedenborg says, in their affections; that temptation consists in a struggle between good and bad angels within men; and that by this means God assists men in these temptations, since of themselves they could do nothing. Indeed B. Swedenborg maintains, that there is an universal influx from God into the souls of men, inspiring them especially with the belief of the divine unity. This efflux of divine light on the spiritual world he compares to the efflux of the light from the sun in the natural world.

Priestley's Letters to the New Jerusalem Church, p. 4, &c.

Swedenborg ‖ Swift.

"There are (says B. Swedenborg) two worlds, the natural and the spiritual, entirely distinct, though perfectly corresponding to each other; that at death a man enters into the spiritual world, when his soul is clothed with a body, which he terms *substantial*, in opposition to the present *material* body, which, he says, is never to rise out of the grave."

SWEEP, in the sea-language, is that part of the mould of a ship where she begins to compass in the rung-heads; also when the hauser is dragged along the bottom of the sea to recover any thing that is sunk, they call this action *sweeping for it*.

SWEET, in the wine trade, denotes any vegetable juice, whether obtained by means of sugar, raisins, or other foreign or domestic fruit, which is added to wines with a design to improve them.

SWEIN-MOT. See *Forest Courts*.

SWERTIA, Marsh Gentian, a genus of plants belonging to the class pentandria, and in the natural system ranging under the 20th order, *rotaceæ*. See Botany *Index*.

SWIETENIA, Mahogany, a genus of plants belonging to the class decandria, and in the natural system arranged under the 54th order, *miscellaneæ*. See Botany and Materia Medica *Index*.

The first use to which mahogany was applied in England, was to make a box for holding candles. Dr Gibbons, an eminent physician in the latter end of the 17th and beginning of the 18th century, had a brother, a West India captain, who brought over some planks of this wood as ballast. As the Doctor was then building a house in King-street, Covent Garden, his brother thought they might be of service to him. But the carpenters, finding the wood too hard for their tools, they were laid aside for a time as useless. Soon after, Mrs Gibbons, wanting a candle-box, the Doctor called on his cabinet-maker to make him one of some wood that lay in his garden. Wollaston, the cabinet-maker also complained that it was too hard. The Doctor said he must get stronger tools. The candle-box was made and approved; insomuch, that the Docter then insisted on having a bureau made of the same wood, which was accordingly done; and the fine colour, polish, &c. were so pleasing, that he invited all his friends to come and see it. Among them was the duchess of Buckingham. Her Grace begged some of the same wood of Dr Gibbons, and employed Wollaston to make her a bureau also; on which the fame of mahogany and Mr Wollaston was much raised, and things of this sort became general.

SWIFT, Dr Jonathan, so universally admired as a wit and classical writer of the English language, was born in Dublin on November 30th 1667. His father was an attorney, and of a good family; but dying poor, the expence of his son's education was defrayed by his friends. At the age of six young Swift was sent to the school of Kilkenny, whence he was removed in his 15th year to Trinity College, Dublin.

In his academical studies (says Dr Johnson) he was either not diligent or not happy. The truth appears to be,

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be, that he despised them as intricate and useless. He told Mr Sheridan, his last biographer, that he had made many efforts, upon his entering the college, to read some of the old treatises on logic writ by Smeglesius, Keckermannus, Burgersdicius, &c. and that he never had patience to go through three pages of any of them, he was so disgusted at the stupidity of the work. When he was urged by his tutor to make himself master of this branch, then in high estimation, and held essentially necessary to the taking of a degree, Swift asked him, What it was he was to learn from those books? His tutor told him, The art of reasoning. Swift said, That he found no want of any such art; that he could reason very well without it; and that, as far as he could observe, they who had made the greatest proficiency in logic had, instead of the art of reasoning, acquired the art of wrangling; and instead of clearing up obscurities, had learned how to perplex matters that were clear enough before. For his own part, he was contented with that portion of reason which God had given him; and he would leave it to time and experience to strengthen and direct it properly; nor would he run the risk of having it warped or falsely biassed by any system of rules laid down by such stupid writers, of the bad effects of which he had but too many examples before his eyes in those reckoned the most acute logicians. Accordingly, he made a firm resolution, that he never would read any of those books; which he so pertinaciously adhered to, that though his degree was refused him the first time of sitting for it, on account of his not answering in that branch, he went into the hall a second time as ill prepared as before; and would also have been stopped a second time, on the same account, if the interest of his friends, who well knew the inflexibility of his temper, had not stepped in, and obtained it for him; though in a manner little to his credit, as it was inserted in the College Registry, that he obtained it *speciali gratia*, "by special favour;" where it remains upon record. But this circumstance is explained by others, that the favour was in consequence of Swift's distinguished talents.

"He remained in the college near three years after this, not through choice, but necessity, little known or regarded. By scholars he was reckoned a blockhead; and as the lowness of his circumstances would not permit him to keep company with persons of an equal rank with himself, upon an equal footing, he scorned to take up with those of a lower class, or be obliged to those of a higher. He lived therefore much alone, and his time was employed in pursuing his course of reading in history and poetry, then very unfashionable studies for an academic; or in gloomy meditations on his unhappy circumstances. Yet, under this heavy pressure, the force of his genius broke out, in the first rude draught of the Tale of a Tub, written by him at the age of 19, though communicated to nobody but his chamber-fellow Mr Waryng; who, after the publication of the book, made no scruple to declare, that he had read the first sketch of it in Swift's hand-writing when he was of that age."

In 1688, being, by the death of Godwin Swift his uncle, who had chiefly supported him, left without subsistence, he went to consult his mother, who then lived at Leicester, about the future course of his life; and, by her direction, solicited the advice and patronage of Sir William Temple, whose father had lived in great friendship with Godwin Swift. Temple received him with great kindness, and was so much pleased with his conversation, that he detained him two years in his house, and recommended him to King William, who offered to make him a captain of horse. This not suiting his disposition, and Temple not having it quickly in his power to provide for him otherwise, Swift left his patron (1694) in discontent; having previously taken his master's degree at Oxford, by means of a testimonial from Dublin, in which the words of disgrace were omitted. He was resolved to enter into the church, where his first preferment was only 100l. a-year, being the prebend of *Kilroot* in *Conner;* which some time afterwards, upon Sir William Temple's earnestly inviting him back to his house at Moorpark, he resigned in favour of a clergyman far advanced in years and burdened with a numerous family. For this man he solicited the prebend, to which he himself inducted him.

In 1699 Swift lost his patron Sir William Temple, who left him a legacy in money, with the property of his manuscripts; and, on his death-bed, obtained for him a promise from the king of the first prebend that should become vacant at Westminster or Canterbury. That this promise might not be forgotten, Swift dedicated to the king the posthumous works with which he was entrusted, and for a while attended the court; but soon found his solicitations hopeless. He was then invited by the earl of Berkeley to accompany him into Ireland, where, after suffering some cruel disappointments, he obtained the livings of Laracor and Rathbeggin in the diocese of Meath; and soon afterwards invited over the unfortunate Stella, a young woman of the name of Johnson, whose life he contrived to embitter, and whose days, though he certainly loved her, we may confidently affirm, he shortened by his caprice.

This lady is generally believed to have been the daughter of Sir William Temple's steward; but her niece, a Mrs Hearn, assured Mr Berkeley, the editor of a volume of letters intitled *Literary Relics*, that her father was a merchant, and the youngest brother of a good family in Nottingham-shire; that her mother was the intimate friend of Lady Gifford, Sir William's sister; and that she herself was educated in the family with his niece, the late Mr Temple of Moorpark by Farnham *. This story would be intitled to the fullest credit, had not Mrs Hearn affirmed, in the same letter, that before the death of Sir William Temple, Mrs Johnson's little fortune had been greatly injured by the South sea bubbles, which are known to have injured no person till the year 1720: (See COMPANY, II. 1.). When one part of a narrative is so palpably false, the remainder will always be received with hesitation. But whether Miss Johnson was the daughter of Temple's steward or of the friend of Lady Gifford, it is certain that Sir William left her 1000l.; and that, accompanied by Mrs Dingley, whose whole fortune amounted to an annuity of 27l. for life, she went, in consequence of Swift's invitation, to Laracor. With these two ladies he passed his hours of relaxation, and to them he opened his bosom; but they never resided in the same house, nor did he see either without a witness.

* See *Inquiry into the life of Dean Swift, prefixed to Literary Relics*, printed in 1789 for Elliot and Kay.

In 1701, Swift published *A Discourse of the Contests and Dissensions in Athens and Rome*. It was his first work, and indeed the only which he ever expressly acknowledged.

knowledged. According to his constant practice he had concealed his name; but after its appearance, paying a visit to some Irish bishop, he was asked by him if he had read that pamphlet, and what its reputation was in London. Upon his replying that he believed it was very well liked in London; "Very well liked!" said the bishop with some emotion. "Yes, Sir, it is one of the finest tracts that ever was written, and Bishop Burnet is one of the best writers in the world." Swift, who always hated Burnet with something more than political rancour, immediately questioned his right to the work when he was told by the bishop that he was "a young man;" and still persisting to doubt of the justice of Burnet's claim on account of the dissimilarity of the style of the pamphlet from that of his other works, he was told that he was "a very positive young man," as no person in England but Bishop Burnet was capable of writing it. Upon which Swift replied, with some indignation, I am to assure your lordship, however, that Bishop Burnet did *not* write the pamphlet, for I wrote it myself. And thus was he forced in the heat of argument to avow what otherwise he would have for ever concealed.

Early in the ensuing spring King William died; and Swift, on his next visit to London, found Queen Anne upon the throne. It was generally thought, upon this event, that the Tory party would have had the ascendant; but, contrary to all expectation, the Whigs had managed matters so well as to get entirely into the queen's confidence, and to have the whole administration of affairs in their hands. Swift's friends were now in power; and the Whigs in general, knowing him to be the author of the Discourse on the Contests, &c. which was written in defence of King William and his ministers against the violent proceedings of the house of commons, considered themselves as much obliged to him, and looked upon him as fast to their party. But Swift thought with the Whigs only in the state; for with respect to the church his principles were always those of a Tory. He therefore declined any intimate connection with the leaders of the party, who at that time professed what was called *low church principles*. But what above all shocked him, says Mr Sheridan, was their inviting Deists, Freethinkers, Atheists, Jews, and Infidels, to be of their party, under pretence of moderation, and allowing a general liberty of conscience. As Swift was in his heart a man of true religion, he could not have borne, even in his private character, to have mixed with such a motley crew. But when we consider his principles in his political capacity, that he looked upon the church of England, as by law established, to be the main pillar of our newly erected constitution, he could not, consistently with the character of a good citizen, join with those who considered it more as an ornament than a support to the edifice; and could therefore look on with composure while it was undermining, or could even open the gate to a blind multitude, to try, like Sampson, their strength against it, and consider it only as sport. With such a party, neither his religious nor political principles would suffer him to join; and with regard to the Tories, as is usual in the violence of factions, they had run into opposite extremes, equally dangerous to the state. He was therefore during the earlier part of the queen's reign of no party, but employed himself in discharging the duties of his function, and in publishing from time to time such tracts as he thought might be useful. In the year 1704 he published the *Tale of a Tub*, which, considered merely as a work of genius, is unquestionably the greatest which he ever produced; but the levity with which religion was thought to be there treated, raised up enemies to him among all parties, and eventually precluded him from a bishopric. From that period till the year 1708, he seems to have employed himself in solitary study; but he then gave successively to the public *The Sentiments of a Church of England man*, the ridicule of astrology under the name of *Bickerstaff*, the *Argument against abolishing Christianity*, and the defence of the *Sacramental Test*.

Soon after began the busy and important part of Swift's life. He was employed (1710) by the primate of Ireland to solicit the queen for a remission of the first fruits and twentieth parts to the Irish clergy. This introduced him to Mr Harley, afterwards earl of Oxford, who, though a Whig himself, was at the head of the Tory ministry, and in great need of an auxiliary so able as Swift, by whose pen he and the other ministers might be supported in pamphlets, poems, and periodical papers. In the year 1710 was commenced the *Examiner;* of which Swift wrote 33 papers, beginning his first part of it on the 10th of November 1711. The next year he published *the Conduct of the Allies* ten days before the parliament assembled; and soon afterwards, *Reflections on the Barrier Treaty*. The purpose of these pamphlets was to persuade the nation to a peace, by showing that "mines had been exhausted and millions destroyed" to secure the Dutch and aggrandize the emperor, without any advantage whatever to Great Britain. Though these two publications, together with his *Remarks on the Bishop of Sarum's Introduction to the third Volume of his History of the Reformation*, certainly turned the tide of popular opinion, and effectually promoted the designs of the ministry, the best preferment which his friends could venture to give him was the deanery of St Patrick's, which he accepted in 1713. In the midst of his power and his politics he kept a journal of his visits, his walks, his interviews with ministers, and quarrels with his servant, and transmitted to Mrs Johnson and Mrs Dingley, to whom he knew that whatever befel him was interesting: but in 1714 an end was put to his power by the death of the queen, which broke down at once the whole system of Tory politics, and nothing remained for him but to withdraw from persecution to his deanery.

In the triumph of the Whigs, Swift met with every mortification that a spirit like his could possibly be exposed to. The people of Ireland were irritated against him beyond measure; and every indignity was offered him as he walked the streets of Dublin. Nor was he insulted by the rabble only; for persons of distinguished rank and character forgot the decorum of common civility to give him a personal affront. While his pride was hurt by such indignities, his more tender feelings were also often wounded by base ingratitude. In such a situation he found it in vain to struggle against the tide that opposed him. He silently yielded to it, and retired from the world to discharge his duties as a clergyman, and attend to the care of his deanery. That no part of his time might lie heavy on his hands, he employed his leisure hours on some historical attempts relating to the change of the ministers and the conduct of the ministry;

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and completed the history of the four last years of the queen, which had been begun in her lifetime, but which he never published. Of the work which bears that title, and is said to be his, Dr Johnson doubts the genuineness; and it certainly is not such as we should have expected from a man of Swift's sagacity and opportunities of information.

In the year 1716 he was privately married to Mrs Johnson by Dr Ashe bishop of Clogher; but the marriage made no change in their situation, and it would be difficult to prove (says Lord Orrery) that they were ever afterwards together but in the presence of a third person. The dean of St Patrick's lived in a private manner, known and regarded only by his friends, till about the year 1720 that he published his first political pamphlet relative to Ireland, intitled *A Proposal for the Universal Use of Irish Manufactures;* which so roused the indignation of the ministry that they commenced a prosecution against the printer, and thus drew the attention of the public to the pamphlet, and at once made its author popular.

Whilst he was enjoying the laurels which this work had wreathed for him, his felicity, as well as that of his wife, was interrupted by the death of Mrs Van Homrigh, and the publication of his poem called *Cadenus and Vanessa*, which brought upon him much merited obloquy. With Mrs Van Homrigh he became acquainted in London during his attendance at court; and finding her possessed of genius and fond of literature, he took delight in directing her studies, till he got insensibly possession of her heart. From being proud of his praise, she grew fond of his person; and despising vulgar restraints, she made him sensible that she was ready to receive him as a husband. She had wit, youth, beauty, and a competent fortune to recommend her; and for a while Swift seems to have been undetermined whether or not he should comply with her wish. She had followed him to Ireland, where she lived in a house about twelve miles distant from Dublin; and he continued to visit her occasionally, and to direct her studies as he had done in London; but with these attentions she was not satisfied, and at last sent to him a letter written with great ardour and tenderness, insisting that he should immediately accept or refuse her as a wife. His answer, which probably contained the secret of his marriage, he carried himself; and having indignantly thrown it on the lady's table, instantly quitted the house, we believe without speaking to her, and returned to Dublin to reflect on the consequences of his own conduct. These were dreadful. Mrs Van Homrigh survived her disappointment but a few weeks; during which time she cancelled a will that she had made in his favour, and ordered the poem to be published in which Cadenus had proclaimed her excellence and confessed his love.

His patriotism again burst forth in 1724 to obstruct the currency of Wood's halfpence; and his zeal was crowned with success. Wood had obtained a patent to coin 180,000l. in halfpence and farthings for the kingdom of Ireland; and was about to turn his brass into gold, when Swift, finding that the metal was debased to an enormous degree, wrote letters under the name of *M. B. Drapier* to show the folly of giving gold and silver for coin not worth a third part of its nominal value. A prosecution was carried on against the printer; and Lord Carteret, then lord-lieutenant, issued a proclamation, offering 300l. for discovering the author of the fourth letter. The day after it was published there was a full levee at the castle. The lord-lieutenant was going round the circle, when Swift abruptly entered the chamber, and pushing his way through the crowd, never stopped till he got within the circle; where, with marks of the highest indignation in his countenance, he addressed the lord-lieutenant with the voice of a Stentor, that re-echoed through the room, "So, my lord-lieutenant, this is a glorious exploit that you performed yesterday, in issuing a proclamation against a poor shopkeeper, whose only crime is an honest endeavour to save his country from ruin. You have given a noble specimen of what this devoted nation is to hope for from your government. I suppose you expect a statue of copper will be erected to you for this service done to Wood." He then went on for a long time, inveighing in the bitterest terms against the patent, and displaying in the strongest colours all the fatal consequences of introducing that execrable coin. The whole assembly were struck mute with wonder at this unprecedented scene. For some time a profound silence ensued. When Lord Carteret, who had listened with great composure to the whole speech, made this fine reply, in a line of Virgil's:

Res dura, et regni novitas me talia cogunt
Moliri.

From this time Swift was known by the name of *the Dean*, and was acknowledged by the populace as the champion, patron, and instructor of Ireland.

In 1727 he returned to England; where, in conjunction with Pope, he collected three volumes of miscellanies; and the same year he sent into the world his *Gulliver's Travels*, a production which was read by the high and the low, and filled every reader with a mingled emotion of merriment and amazement. Whilst he was enjoying the reputation of this work, he was suddenly called to a home of sorrow. Poor Stella was sinking into the grave; and after a languishing decay of about two months, died in her 44th year, on January 28. 1728. How much he wished her life is shown by his papers; nor can it be doubted that he dreaded the death of her whom he loved most, aggravated by the consciousness that himself had hastened it. With her vanished all his domestic enjoyments, and of course he turned his thoughts more to public affairs; in the contemplation of which he could see nothing but what served to increase the malady. The advances of old age, with all its attendant infirmities; the death of almost all his old friends; the frequent returns of his most dispiriting maladies, deafness and giddiness; and, above all, the dreadful apprehensions that he should outlive his understanding, made life such a burden to him, that he had no hope left but a speedy dissolution, which was the object of his daily prayer to the Almighty.

The severity of his temper increasing, he drove his acquaintance from his table, and wondered why he was deserted. In 1732, he complains, in a letter to Mr Gay, that "he had a large house, and should hardly find one visitor if he was not able to hire him with a bottle of wine:" and, in another to Mr Pope, "that he was in danger of dying poor and friendless, even his female friends having forsaken him; which," as he says, "vexed

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ed him most." These complaints were afterwards repeated in a strain of yet greater sensibility: "All my friends have forsaken me.

"*Vertiginosus, inops, surdus, male gratus amicis.*

"Deaf, giddy, helpless, left alone,
"To all my friends a burden grown."

The fits of giddiness and deafness to which he had been subjected from his boyish years, and for which he thought walking or riding the best remedy, became more frequent and violent as he grew old; and the presentiment which he had long entertained of that wretchedness which would inevitably overtake him towards the close of life, clouded his mind with melancholy and tinged every object around him. How miserable he was rendered by that gloomy prospect, we may learn from the following remarkable anecdote mentioned by Mr Faulkner in his letter to Lord Chesterfield. "One time, in a journey from Drogheda to Navan, the dean rode before the company, made a sudden stop, dismounted from his horse, fell on his knees, lifted up his hands, and prayed in the most devout manner. When his friends came up, he desired and insisted on their alighting; which they did, and asked him the meaning. "Gentlemen," said he, "pray join your hearts in fervent prayers with mine, that I may never be like this oak-tree, which is decayed and withered at top, while the other parts are sound." In 1736, while he was writing a satire called the *Legion Club* against the Irish parliament, he was seized with so dreadful a fit of his malady, that he left the poem unfinished; and never after attempted a composition that required a course of thinking. From this time his memory gradually declined, his passions perverted his understanding, and, in 1741, he became utterly incapable of conversation; and it was found necessary to appoint legal guardians to his person and his fortune. He now lost all sense of distinction. His meat was brought to him cut into mouthfuls; and he would never touch it while the servant staid; and at last, after it stood perhaps an hour, would eat it walking; for he continued his old habit, and was on his feet ten hours a day. During next year a short interval of reason ensuing, gave hopes of his recovery; but in a few days he sunk into lethargic stupidity, motionless, heedless, and speechless. After a year of total silence, however, when his housekeeper told him that the usual illuminations were preparing to celebrate his birth, he answered, "It is all folly; they had better let it alone." He at last sunk into a perfect silence, which continued till the 29th of October 1745, when he expired without a struggle, in his 78th year. The behaviour of the citizens on this occasion gave the strongest proof of the deep impression he had made on their minds. Though he had been so many years to all intents and purposes dead to the world, and his departure from that state seemed a thing rather to be wished than deplored, yet no sooner was his death announced, than they gathered from all quarters, and forced their way in crowds into the house, to pay the last tribute of grief to their departed benefactor. Nothing but lamentations were heard all around the quarter where he lived, as if he had been cut off in the vigour of his years. Happy were they who first got into the chamber where he lay, to procure, by bribes to the servants, locks of his hair, to be handed down as sacred relics to their posterity; and so eager were numbers to obtain at any price this precious memorial, that in less than an hour, his venerable head was entirely stripped of all its silver ornaments, so that not a hair remained. By his will, which was dated in May 1740, just before he ceased to be a reasonable being, he left about 1200l. in specific legacies; and the rest of his fortune, which amounted to about 11,000l. to erect and endow an hospital for lunatics and idiots. He was buried in the most private manner, according to directions in his will, in the great aisle of St Patrick's cathedral, and, by way of monument, a slab of black marble was placed against the wall, on which was engraved the following Latin epitaph, written by himself:

Hic depositum est corpus
JONATHAN SWIFT, S. T. P.
Hujus Ecclesiæ Cathedralis
Decani:
Ubi sæva indignatio
Ulterius cor lacerare nequit.
Abi, viator,
Et imitare, si poteris,
Strenuum pro virili libertatis vindicem.
Obiit anno (1745)
Mensis (Octobris) die (29.)
Ætatis anno 78.

Swift undoubtedly was a man of native genius. His fancy was inexhaustible; his conceptions were lively and comprehensive; and he had the peculiar felicity of conveying them in language equally correct, free, and perspicuous. His penetration was as quick as intuition; he was indeed the critic of nature; and no man ever wrote so much and borrowed so little.

As his genius was of the first class, so were some of his virtues. The following anecdote will illustrate his filial piety. His mother died in 1710, as appears by a memorandum in one of the account-books which Dr Swift always made up yearly, and on each page entered minutely all his receipts and expences in every month, beginning his year from November 1. He observed the same method all his lifetime till his last illness. At the foot of that page which includes his expences of the month of May 1710, at the glebe house of Laracor in the county of Meath, where he was then resident, are these remarkable words, which show at the same time his filial piety, and the religious use which he thought it his duty to make of that melancholy event. "*Mem.* On Wednesday, between seven and eight in the evening, May 10. 1710. I received a letter in my chamber at Laracor (Mr Percival and Jo. Beaumont being by) from Mrs F—, dated May 9, with one inclosed, sent by Mrs Worral at Leicester to Mrs F—, giving an account that my dear mother, Mrs Abigail Swift, died that morning, Monday April 24. 1710, about ten o'clock, after a long sickness: being ill all winter, and lame; and extremely ill about a month or six weeks before her death. I have now lost my barrier between me and death. God grant I may live to be as well prepared for it as I confidently believe her to have been! If the way to heaven be through piety, truth, justice, and charity, she is there. J. S." He always treated his mother, during her life, with the utmost duty and affection; and she sometimes came to Ireland to visit him after his settlement at Laracor.

The liberality of the dean hath been a topic of just

Swift. encomium with all his admirers; nor could his enemies deny him this praise. In his domestic affairs, he always acted with strict economy. He kept the most regular accounts; and he seems to have done this chiefly with a view to increase his power of being useful. "His income, which was little more than 700l. per annum, he endeavoured to divide into three parts, for the following purposes. First, to live upon one-third of it. Secondly, to give another third in pensions and charities, according to the manner in which persons who received them had lived: and the other third he laid by, to build an hospital for the reception of idiots and lunatics." "What is remarkable in this generous man, is this (says Mr F.), that when he lent money upon bond or mortgage, he would not take the legal interest, but one per cent. below it."

His charity appears to have been a settled principle of duty more than an instinctive effort of good nature: but as it was thus founded and supported, it had extraordinary merit, and seldom failed to exert itself in a manner that contributed most to render it beneficial. He did not lavish his money on the idle and the worthless. He nicely discriminated characters, and was seldom the dupe of imposition. Hence his generosity always turned to an useful account; while it relieved distress, it encouraged industry, and rewarded virtue. We dwell with great pleasure on this truly excellent and distinguishing part of the dean's character: and for the sake of his charity we can overlook his oddities, and almost forgive his faults. He was a very peculiar man in every respect. Some have said, "What a man he would have been, had he been without those whims and infirmities which shaded both his genius and his character!" But perhaps the peculiarities complained of were inseparable from his genius. The vigour and fertility of the root could not fail now and then of throwing out superfluous suckers. What produced these, produced also the more beautiful branches, and gave the fruit all its richness.

It must be acknowledged, that the dean's fancy hurried him into great absurdities and inconsistencies, for which nothing but his extraordinary talents and noble virtues, discovered in other instances, could have atoned. The rancour he discovered on all occasions towards the dissenters is totally unjustifiable. No sect could have merited it in the degree in which he always showed it to them; for, in some instances, it bordered on downright persecution. He doubtless had his reasons for exposing their principles to ridicule, and might perhaps have sufficient grounds for some of his accusations against their principal leaders in Ireland; but nothing could justify his virulence against the whole body. In a short poem on one class of dissenters he bestowed a stricture upon Bettesworth, a lawyer eminent for his insolence to the clergy, which, from a very considerable reputation, brought him into immediate and universal contempt. Bettesworth, enraged at his disgrace and loss, went to the dean, and demanded whether he was the author of that poem? "Mr Bettesworth (answered he), I was in my youth acquainted with great lawyers, who, knowing my disposition to satire, advised me, if any *scoundrel* or *blockhead* whom I had lampooned should ask, 'Are you the author of this paper?', to tell him that I was not the author; and therefore, I tell *you*, Mr Bettesworth, that I am not the author of these lines."

Swift has been accused of irreligion and misanthropy, on account of his Tale of a Tub, and his Yahoos in Gulliver's Travels; but both charges seem to be ill-founded, or at least not supported by that evidence. The *Tale of a Tub* holds up to ridicule superstitious and fanatical absurdities; but it never attacks the essentials of religion: and in the story of the *Yahoos*, disgusting we confess, there appears to us as little evidence that the author hated his own species, as in the poems of *Strephon and Chloe*, and the *Ladies Dressing room*, that he approved of grossness and filth in the female sex. We do not indeed, with his fondest admirers, perceive the moral tendency of the Voyage to the Houyhnhnms, or consider it as a satire admirably calculated to reform mankind; but neither do we think that it can possibly corrupt them, or lead them to think meanly of their rational nature. According to Sheridan, "the design of this apologue is to place before the eyes of man a picture of the two different parts of his frame, detached from each other, in order that he may the better estimate the true value of each, and see the necessity there is that the one should have an absolute command over the other. In your merely animal capacity, says he to man, without reason to guide you, and actuated only by a blind instinct, I will show you that you would be degraded below the beasts of the field. That very form, that very body, you are now so proud of, as giving you such a superiority over all other animals, I will show you, owe all their beauty, and all their greatest powers, to their being actuated by a rational soul. Let that be withdrawn, let the body be inhabited by the mind of a brute, let it be prone as theirs are, and suffered like theirs to take its natural course, without any assistance from art, you would in that case be the most deformed, as to your external appearance, the most detestable of all creatures. And with regard to your internal frame, filled with all the evil dispositions and malignant passions of mankind, you would be the most miserable of beings, living in a continued state of internal vexation, and of hatred and warfare with each other.

"On the other hand, I will show another picture of an animal endowed with a rational soul, and acting uniformly up to the dictates of right reason. Here you may see collected all the virtues, all the great qualities, which dignify man's nature and constitute the happiness of his life. What is the natural inference to be drawn from these two different representations? Is it not evidently a lesson to mankind, warning them not to suffer the animal part to be predominant in them, lest they resemble the vile Yahoo, and fall into vice and misery; but to emulate the noble and generous Houyhnhnm, by cultivating the rational faculty to the utmost; which will lead them to a life of virtue and happiness."

Such *may* have been the author's intention; but it is not sufficiently obvious to produce the proper effect, and is indeed hardly consistent with that incapability under which he represents the Yahoos of ever acquiring, by any culture, the virtues of the noble Houyhnhnms.

With respect to his religon, it is a fact unquestionable, that while the power of speech remained, he continued constant in the performance of his private devotions; and in proportion as his memory failed, they were

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were gradually shortened, till at last he could only repeat the Lord's prayer, which he continued to do till the power of utterance for ever ceased. Such a habit as this could not have been formed but by a man deeply impressed with a conviction of the truth and importance of revelation.

The most inexcusable part of Swift's conduct is his treatment of Stella and Vanessa, for which no proper apology can be made, and which the vain attempts of his friends have only tended to aggravate. One attributes his singular conduct to a peculiarity in his constitution; but if he knew that he was incapable of fulfilling the duties of the married state, how came he to tie one of the ladies to himself by the marriage ceremony, and in the most explicit terms to declare his passion to the other? And what are we to think of the sensibility of a man who, strongly attached as he seems to have been to both, could, without speaking, fling a paper on the table of the one, which "proved (as our author expresses it) her death-warrant," and could throw the other, his beloved Stella, in her last illness, into unspeakable agonies, and "never see her more, for only adjuring him, by their friendship, to let her have the satisfaction of dying at least, though she had not lived, his acknowledged wife?" Another apologist insinuates, upon something like evidence, that Stella bore a son to Swift, and yet labours to excuse him for not declaring her his wife, because she had agreed at the marriage that it should remain a secret from all the world unless the discovery should be called for by *urgent necessity;* but what could be meant by the term *urgent necessity*, unless it alluded to the birth of children, he confesses that it would be hard to say. The truth we believe to be what has been said by Johnson, that the man whom Stella had the misfortune to love was fond of singularity, and desirous to make a mode of happiness for himself different from the general course of things and the order of Providence; he wished for all the pleasures of perfect friendship, without the uneasiness of conjugal restraint. But with this state poor Stella was not satisfied; she never was treated as a wife, and to the world she had the appearance of a mistress. She lived sullenly on, hoping that in time he would own and receive her. This, we believe, he offered at last to do, but not till the change of his manners and the depravation of his mind made her tell him, that "it was too late."

The natural acrimony of Swift's temper had been increased by repeated disappointments. This gave a splenetic tincture to his writings, and amidst the duties of private and domestic life it too frequently appeared to shade the lustre of his more eminent virtues.—The dean hath been accused of avarice, but with the same truth as he hath been accused of infidelity. In detached views, no man was more liable to be mistaken. Even his genius and good sense might be questioned, if we were only to read some passages of his writings. To judge fairly and pronounce justly of him as a man and as an author, we should examine the uniform tenor of his disposition and conduct, and the general nature and design of his productions. In the latter he will appear great, and in the former good; notwithstanding the puns and puerilities of the one, and the absurdities and inconsistencies of the other.

SWIFT, a species of swallow. See HIRUNDO, ORNITHOLOGY *Index*.

Swimming.

SWIMMING, the art of suspending one's self on water, and at the same time making a progressive motion through it.

1
Swimming not natural to man.

As swimming is not natural to man, it is evident that at some period it must have been unknown among the human race. Nevertheless there are no accounts of its origin to be found in the history of any nation; nor are there any nations so barbarous but that the art of swimming is known among them, and that in greater perfection than among civilized people. It is probable, therefore, that the art, though not absolutely natural, will always be acquired by people in a savage state from imitating the brute animals, most of whom swim naturally. Indeed so much does this appear to be the case, that very expert swimmers have recommended it to those who wished to learn the art, to keep some frogs in a tub of water constantly beside them, and to imitate the motions by which they move through that element.

2
Depends on a simple principle.

The theory of swimming depends upon one very simple principle; namely, that if a force be applied to any body, it will always move towards that side where there is the least resistance. Thus, if a person standing in a boat pushes with a pole against the side or any other part of the vessel in which he stands, no motion will ensue; for as much as he presses in one direction with the pole, just so much does the action of his feet, on which the pressure of the pole must ultimately rest, push the vessel the other way: but if, instead of the side of the vessel, he pushes the pole against the shore, then only one force acts upon it, namely, that of the feet; which being resisted only by the fluid water, the boat begins to move from the shore. Now the very same thing takes place in swimming, whether the animal be man, quadruped, bird, or fish. If we consider the matter simply, we may suppose an animal in such a situation that it could not possibly swim: thus, if we cut off the fins and tail of a fish, it will indeed float in consequence of being specifically lighter than the water, but cannot make any progressive motion, or at least but very little, in consequence of wriggling its body; but if we allow it to keep any of its fins, by striking them against the water in any direction, the body moves the contrary way, just as a boat moves the contrary way to that in which the oars strike the water. It is true, that as the boat is but partly immerged in the water, the resistance is comparatively less than when a frog or even any other quadruped swims; but a boat could certainly be rowed with oars though it was totally immerged in water, only with less velocity than when it is not. When a man swims, he in like manner strikes the water with his hands, arms, and feet; in consequence of which the body moves in a direction contrary to the stroke. Upon this principle, and on this only, a man may either ascend, descend, or move obliquely in any possible direction, in the water. One would think, indeed, that as the strength of a man's arms and legs is but small, he could make but very little way by any stroke he could give the water, considering the fluidity of that element. Nevertheless it is incredible what expert swimmers will perform in this way; of which Mr Forster gives a most remarkable instance in the inhabitants of Otaheite; whose agility, he tells us, was such, that when a nail was thrown overboard, they would jump after it into the sea, and never fail to catch it before it reached to the bottom.

As to the practice of swimming, there are but few directions

Swimming directions which can be given. The great obstacle is the natural dread which people have of being drowned; and this it is impossible to overcome by any thing but accustoming ourselves to go into the water. With regard to the real danger of being drowned, it is but little; and on innumerable occasions arises entirely from the terror above mentioned, as will appear from the following observations by Dr Franklin.

3 Observations by Dr Franklin.

"1st, That though the legs, arms, and head, of a human body, being solid parts, are specifically somewhat heavier than fresh water, yet the trunk, particularly the upper part, from its hollowness, is so much lighter than water, as that the whole of the body, taken together, is too light to sink wholly under water, but some part will remain above until the lungs become filled with water; which happens from drawing water into them instead of air, when a person in the fright attempts breathing while the mouth and nostrils are under water.

"2dly, That the legs and arms are specifically lighter than salt water, and will be supported by it; so that a human body would not sink in salt water though the lungs were filled as above, but from the greater specific gravity of the head.

"3dly, That therefore a person throwing himself on his back in salt water, and extending his arms, may easily lie so as to keep his mouth and nostrils free from breathing; and by a small motion of his hands may prevent turning, if he should perceive any tendency to it.

"4thly, That in fresh water, if a man throws himself on his back near the surface, he cannot long continue in that situation, but by a proper action of his hands on the water. If he uses no such action, the legs and lower part of the body will gradually sink till he comes into an upright position; in which he will continue suspended, the hollow of the breast keeping the head uppermost.

"5thly, But if in this erect position the head is kept upright above the shoulders, as when we stand on the ground, the immersion will, by the weight of that part of the head that is out of the water, reach above the mouth and nostrils, perhaps a little above the eyes; so that a man cannot long remain suspended in water with his head in that position.

"6thly, The body continued suspended as before, and upright, if the head be leaned quite back, so that the face looks upwards, all the back part of the head being then under water, and its weight consequently in a great measure supported by it, the face will remain above water quite free for breathing, will rise an inch higher every inspiration, and sink as much every expiration, but never so low as that the water may come over the mouth.

"7thly, If therefore a person unacquainted with swimming, and falling accidentally into the water, could have presence of mind sufficient to avoid struggling and plunging, and let the body take this natural position, he might continue long safe from drowning, till perhaps help would come; for as to the clothes, their additional weight while immersed is very inconsiderable, the water supporting it; though when he comes out of the water, he would find them very heavy indeed."

4 His method of learning to swim.

The method of learning to swim is as follows: The person must walk into water so deep that it will reach to the breast. He is then to lie down gently on the belly, keeping the head and neck perfectly upright, the breast advancing forward, the thorax inflated, and the back bent; then withdrawing the legs from the bottom, and stretching them out, strike the arms forwards in unison with the legs. Swimming on the back is somewhat similar to that on the belly; but with this difference, that although the legs are employed to move the body forwards, the arms are generally unemployed, and the progressive motion is derived from the movement of the legs. In diving, a person must close his hands together, and, pressing his chin upon his breast, make an exertion to bend with force forwards. While in that position, he must continue to move with rapidity under the surface; and whenever he chooses to return to his former situation, he has nothing to do but bend back his head, and he will immediately return to the surface.

It is very common for novices in the art of swimming to make use of corks or bladders to assist in keeping the body above water. Some have utterly condemned the use of these; however, Dr Franklin allows that they may be of service for supporting the body while one is learning what is called the *stroke*, or that manner of drawing in and striking out the hands and feet that is necessary to produce progressive motion. "But (says he) you will be no swimmer till you can place confidence in the power of the water to support you: I would therefore advise the acquiring that confidence in the first place, especially as I have known several who, by a little of the practice necessary for that purpose, have insensibly acquired the stroke, taught as it were by nature.

5 and of acquiring confidence.

"The practice I mean is this: Choosing a place where the water deepens gradually, walk coolly into it till it is up to your breast: then turn round your face to the shore, and throw an egg into the water, between you and the shore; it will sink to the bottom, and be easily seen there, if the water is clear. It must lie in the water so deep as that you cannot reach it to take it up but by diving for it. To encourage yourself in order to do this, reflect that your progress will be from deeper to shallower water; and that at any time you may, by bringing your legs under you, and standing on the bottom, raise your head far above the water: then plunge under it with your eyes open, throwing yourself towards the egg, and endeavouring, by the action of your hands and feet against the water, to get forward till within reach of it. In this attempt you will find that the water buoys you up against your inclination; and it is not so easy a thing to sink as you imagined; that you cannot but by active force get down to the egg. Thus you feel the power of the water to support you, and learn to confide in that power; while your endeavours to overcome it, and to reach the egg, teach you the manner of acting on the water with your feet and hands; which action is afterwards used in swimming to support your head higher above water, or to go forward through it."

6 Swimming a pleasant and useful exercise.

As swimming is a healthy exercise and a pleasant amusement, and as a dexterity in it may frequently put it in a man's power to save his own life and the lives of his fellow-creatures, perhaps of his dearest friends, it can neither be useless nor uninteresting to consider a few of the evolutions which a swimmer must be master of, that he move in any direction without difficulty, without danger, and without being unnecessarily fatigued.

These

Swimming. 7 How to turn to the right or left.

There are several different ways of turning one's self in swimming. You may do it in this way: Turn the palm of the right hand outwards, extend the arm in the same manner, and make a contrary movement with the left hand and left arm; then, by a gradual motion, incline your head and whole body to the left side, and the evolution will be finished. There is another way which is easier still: Bend your head and body toward that side to which you are going to turn. If you wish to turn to the left, incline the thumb and the right hand toward the bottom, bend the fingers of the right hand, stretch it out, and use it for driving away the water sidewise, or, which is the same thing, for pushing yourself the contrary way. At the same time, with your left hand, the fingers being close, push the water behind you, and all at once turn your body and your face to the left, and the manœuvre will be accomplished. If you wish to turn to the right, you must do with your right hand what you did with your left, and with your left what you did with your right. You must be careful when turning yourself never to stretch out your legs, and be sure that the water be so deep that you be in no danger of hurting yourself.

8 How to turn from the belly to the back.

When you are swimming on your belly, and wish to turn on your back, draw your feet in quickly, and throw them before you; stretch out your hands behind you, and keep your body firm and steady. When you wish to turn from swimming on your back, fold your feet at once under your body as if you were throwing them to the bottom, and at the same instant dart your body forwards, that you may fall upon your belly.

9 The eyes ought to be turned towards heaven.

In swimming, the eyes ought to be turned towards heaven. This is a most important rule, and to the neglect of it many of the accidents which befal swimmers are owing. For when they bend their eyes downwards, they insensibly bend their head too, and thus the mouth being too deep in the water, may admit a quantity of it in breaking; besides, the more the body is stretched, it covers a greater part of the surface of the water, and consequently its specific gravity is less. Any person who will make the experiment will find it impossible to dive while he keeps his head erect and his eyes fixed on the heavens (A).

10 How to swim on the back,

The easiest posture in swimming is lying on the back. When you wish to swim in this posture, lay yourself softly on your back, and raise your breast to the surface of the water, keeping your body extended in the same line. Put your hands easily over the upper part of your thighs, and throw out your legs and draw them in alternately keeping them within two feet of the surface. In this way you may advance in any direction you please. You may perhaps not like having so much of your head under water; there is, however, no way of swimming so easy, so safe, and so little fatiguing. If you wish to swim with great rapidity, you may use your arms as well as your feet; and you will find this the easiest way of breaking the force of the waves.

11 and advance forward.

In swimming on the back, one may advance forward as well as backward. For this purpose the body must be kept straight and extended; the breast inflated, so that the hollow of the back may assume a semicircular form. The hands must recline over the upper parts of the thighs. It is also necessary to raise the legs one after another, and draw them in strongly towards the hams, and then leave them suspended in the water. This way of swimming is not only pleasant, but may serve to rest you when fatigued.

12 How to swim on one side.

When you are tired with swimming on your back and belly, you may swim on one side. When you wish to do this, sink a little your left side and raise your right; you will immediately find yourself on your left side. Move then your left hand without either raising or sinking it; you have only to stretch it and draw it back, as in a straight line, on the surface of the water. Independent of the pleasure which this kind of motion will give you, you will have the satisfaction of seeing both sides of the river.

13 How to swim on the belly without the assistance of the hands.

It is possible to swim on the belly without the assistance of the hands. For this purpose you must keep your breast erect, your neck straight, and fix your hands behind your head, or upon your back, while you move forward by employing your feet. This way is not without its advantages. It is an excellent resource when the arms are seized with a cramp, or with any indisposition which makes it painful to exert them. This in some cases may be preferable to swimming on the back; for while in that attitude, one cannot see before them without turning every instant. If one of your legs be seized with a cramp, take hold of it with the hand opposite to it, and use the other hand and leg to advance or support yourself.

14 How to swim with the hands joined.

A very ancient and graceful mode of swimming, is that of swimming with the hands joined. When you wish to put this in practice, join your hands, keeping the thumbs and fingers towards heaven, so that they may appear above the water; then draw them back and push them forwards alternately from your breast. This method of swimming may be useful in several circumstances, but above all if you are entangled with grass or weeds. Your hands will then open a passage for you.

15 With the hands elevated.

As a person may sometimes have occasion to carry something in his hand in swimming, which he is anxious to preserve from the water, he may swim easily with one hand and hold a parcel in the other, as Cæsar swam with his Commentaries at Alexandria; or one may swim with both hands elevated. To perform this well, the swimmer must raise his breast, and keep it as much inflated as

(A) An interesting question occurs here, which deserves to be considered. Since the body, when spread upon the surface, can be supported with so little exertion, and frequently without any at all, as in swimming on the back, how comes it to pass that a person when drowned sinks and frequently rises again some time afterwards? The reason is this: In the act of drowning, the lungs are filled with water, and consequently the body, being specifically heavier, sinks. It is well known that the human body contains a great quantity of air: this air is at first compressed by the water; and while this is the case the body remains at the bottom: but as soon as the air by its elasticity endeavours to disengage itself from the compression, they body is swelled and expanded, becomes specifically lighter than the water, and consequently rises to the top.

Swimming || Switzerland. as he can, at the same time that he supports the arms above the water. It must not be concealed, that this method of swimming is attended with some danger to one who is not dexterous at the art; for if one should imprudently draw in his breast, when his arms are raised, he would immediately sink to the bottom.

16 How to rise to the surface after diving. When a man plunges into the water, and has reached the bottom, he has only to give a small stroke which his foot against the ground, in order to rise; but an experienced swimmer, if he misses the ground, has recourse to another expedient, which is very pretty, and which has not been much considered. Suppose him at a considerable depth, when he perceives that he cannot reach the bottom. In such a case, he first puts his hands before his face, at the height of his forehead, with the palms turned outwardly; then holding the fore part of his arm vertically, he makes them move backwards and forwards from right to left; that is to say, these two parts of his arms, having the elbow as a kind of pivot, describe very quickly, both the hands being open, and the fingers joined, two small portions of a circle before the forehead, as if he would make the water retire, which he in fact does; and from these strokes given to the water, there results an oblique force, one part of which carries the swimmer upwards.

There are many artificial methods of supporting one's self in water, but we have not room to describe them.—Those who wish to see a full account of them may consult the *Encyclopédie Methodique*.

Swimming of Fish. A great proportion of the inhabitants of the waters have an air-bladder, by which they poise themselves. Their movements chiefly depend upon their tail. See ANATOMY, Part II.; and ICHTHYOLOGY.

SWINDLER, a word which has been lately adopted into the English language, derived from the German word *schwindel*, "to cheat." Swindling has now become so common in several of the great towns of this country, that it is unfortunately too well known to require any description.

SWINE. See SUS, MAMMALIA *Index*.

Swine-Stone. See MINERALOGY *Index*.

SWINGING, a kind of exercise strongly recommended to persons in consumption by some physicians, and disapproved of by others. See MEDICINE *Index*.

SWING-TREE of a waggon, is the bar fastened across the fore-guide, to which the traces of the horses are fastened.

Swing-Wheel, in a royal pendulum, that wheel which drives the pendulum. In a watch or balance clock it is called the crown-wheel.

SWINGLE, in the fireworks in England, the wooden spoke which is fixed to the barrel that draws the wire, and which, by its being forced back by the cogs of the wheel, is the occasion of the force with which the barrel is pulled.

SWITZ, or SCHWEITS, the capital of one of the cantons of Switzerland, to which it gives name, seated on the east side of the lake Lucerne, in N. Lat. 46. 55. E. Long. 8. 30.

1 Situation. SWISSERLAND, or SWITZERLAND, a mountainous district of the south of Europe, forming a republic composed of several independent states or cantons, each governed by its own council and laws, but united into one body by a federal constitution.

2 Boundaries and extent. Switzerland is bounded on the north and east by Germany, on the south by Italy, and on the west by the departments of the Higher and Lower Alps, and the mouths of the Rhone. Its extent from east to west is computed at about 200 British miles, and its breadth from north to south at about 130 British miles. Its area in square English miles is estimated at 23,000.

3 Divisions. Before the French revolution, Switzerland contained 13 independent cantons, and a number of small districts, which were dependent on the cantons. The independent cantons were, 1. BERNE, including the *Pays de Vaud*; 2. FRIBURG; 3. BASIL; 4. SOLEURE; 5. SCHAFFHAUSEN; 6. ZURICH; 7. APPENZEL; 8. LUCERNE; 9. ZUG; 10. SCHWEITZ; 11. UNDERWALDEN; 12. URI; 13. GLARIS.

After the conquest of the country by the French, it was divided into 21 cantons, which were reduced to 19 by the annexation of some districts to France; and since the peace in 1815 they have been increased to 22 by the restitution of the ceded districts, and the addition of Geneva to the number. The following table, from Crowe's *View of the Powers of Europe* (1818), shews the extent and population of each.

	Extent in square German miles.	Population.
Zurich,	51	182,080
Berne,	184	291,600
Lucern,	41	99,972
Uri,	39	14,600
Schwitz,	18	28,900
Underwald,	21	21,200
Glaris,	18	24,000
Zug,	6	14,750
Friburg,	42	89,600
Soleure,	19	48,600
Basil,	13	49,200
Schaffhausen	10	30,000
Appenzel,	11	55,000
St Gall,	58	130,000
Grisons,	173	73,000
Argau,	39	143,000
Thurgau,	23	77,091
Tessin,	82	88,793
Vaud,	86	141,676
Valais,	119	62,809
Neufchatel,	20	50,000
Geneva,	6	40,000
	1079	1,757,031
In English miles	23,000	

Switzerland is the most mountainous country in Europe. Both on the mountains and in the valleys the air is extremely cold in winter; but in summer it is very pleasant, cool, and refreshing in the former, but excessively hot in the latter. Prodigious masses of ice and snow often fall from the mountains in winter, and do a great deal of damage; and most of the streams and rivers take their rise from the thawing of the ice and snow on their sides and tops.

The lower parts of Switzerland are very pleasant and fertile, being diversified with vineyards, corn-fields, meadows, and pasture-grounds. Many petrifactions are found

Switzerland. found both among these and the others, with a variety of fossils. The sands of the rivers yield gold dust, particularly those of the Rhine, the Emmet, and the Aar, the Reuss, the Arve, and the Inn.

The metals of this country being generally found to be brittle, the only mines that are worked are a few of iron. In the lower parts of Switzerland they sow rye, oats, barley, spelt, flax, hemp. Wines of various sorts are also produced by some of them, with a variety of fruits. Of wood for fuel and other uses there is generally plenty; in some places, however, they are obliged to burn sheep's dung, and in others a kind of heath and small shrubs. In the valleys they cultivate saffron with success. The Swiss derive their principal subsistence from their flocks and herds of cattle, which in summer graze on the mountains. Their cheese is much esteemed, especially that of Berne and Griers in the canton of Friburg. Great numbers of horses are also bred here, and bought up for the French cavalry.

5 Lakes. Besides the above-mentioned rivers, the Rhone and the Tesin have their sources in this country. The lakes are very numerous; but the chief are those of Geneva, Neufchatel, Biel, Zurich, Thun, Brien, Constance, and Lucerne. Both rivers and lakes abound with fish, and afford a cheap water-carriage. Switzerland is not so populous as many countries in Europe, but is more so than Spain, Sweden, or Denmark, and is really well peopled considering the great proportion of useless soil it contains.

6 Language, religion, &c. The language generally spoken here is the German, in which also public affairs are transacted; but in those parts of the country that border on Italy or France, a corrupt French or Italian prevails. The two predominant religions are Calvinism and Popery. Of the former are the cantons of Zurich and Berne, the towns of St Gal, Geneva, Muhlhausen, and Biel, the principality of Neufchatel, the greater part of Basle, Schaffhausen, the country of the Grisons, the Thurgau, Toggenburg, Glaris, and the Rhine valley; the frontiers of Appenzel, with a small part of Solothurn, and some places in the mountains of Baden and Sargans. The rest of the Swiss cantons, allies, and dependents, are Popish. For the education of youth there is an university at Basle, and academies at Zurich, Berne, Lausanne, and Geneva; besides gymnasiums and scholæ illustres, both in the Popish and Protestant cantons. There are also societies among them for the improvement of the German language, and the sciences.

7 Manufactures and trade. The principal manufactures are snuff and tobacco, linen of several sorts, lace, thread, silk, and worsted stockings, neckcloths, cotton stuffs, gloves, handkerchiefs, silks of several sorts, gold and silver brocades, a variety of woollen manufactures, hats, paper, leather of all sorts, earthen wares, porcelain, toys, watches, clocks, and other hardwares, &c. The trade of Switzerland is generally promoted by many navigable lakes and rivers. In some of the above manufactures, and in cheese, butter, sheep, horses, black cattle, hides, and skins, the exports are considerable; and as the imports are chiefly grain and salt, with some American and Asiatic goods, there is probably a large balance in their favour. In some parts of Switzerland dress is restrained by sumptuary laws.

8 Character of the Swiss. The Swiss are a brave, honest, hospitable, hardy people; very true to their engagements, friendly and humane. In short, there is not a people in Europe whose national character is better. In their persons they are generally tall, robust, and well-made; but their complexions are none of the best, and those that live in the neighbourhood of the mountains are subject to wens. The women are said to be generally handsome and well-shaped, sensible and modest; yet frank, easy, and agreeable in conversation. Few of the peasants are miserably poor; many of them are rich, especially in the Protestant cantons, and that of Berne in particular.

9 Outline of the history of Switzerland. In the very confined limits to which we are now reduced, we cannot give more than a faint outline of the history of Switzerland. In the first century before the Christian era, we find the natives involved in frequent wars with the Romans, by whom the Helvetii and the Rhætii, two of the most powerful tribes, were entirely subjugated. In the beginning of the 4th century of the Christian era, the Allemanni, a German tribe, made an irruption into Switzerland, occupied the country, and, as is supposed, extirpated the Helvetii. Soon after we find the western part of Switzerland, as far as the Reuss, occupied by the Franks, by whom it was annexed to Burgundy, while the eastern part, or the Grisons, was subject to Theodoric the Goth, and other Italian princes. In the beginning of the 7th century, Christianity was introduced, chiefly by two Irish monks, Columbanus and Gallus. In the beginning of the 10th century, that part of Switzerland which was occupied by the Allemanni, was invaded by the Huns or Ugurs, who in particular ravaged the abbey of St Gal, at that time famous for its power and its literature. The Huns were defeated by Conrad king of Burgundy, about the year 928. Soon after the commencement of the 11th century, the districts of Switzerland began to be regarded as a part of the German empire, and in the two following centuries they gradually became subject to the house of Hapsburgh. In 1307 commenced the struggles of the Swiss with the house of Austria, those glorious struggles which finally terminated in the complete emancipation of that brave people, and in the formation of a confederacy which continued to be the admiration of Europe for nearly five centuries. The transactions which mark this contest between the inhabitants of a small district and a mighty monarch, and in particular the heroism of their great champion William Tell, are familiar to most of our readers. We shall therefore only give a short account of the government and institutions of the Swiss cantons, as they existed previous to the late revolution, and shall conclude this article with a brief narrative of the proceedings of the French, when they entered Switzerland in 1797.

10 Constitution of the Swiss cantons before the late revolution. With respect to the government and constitution of the Swiss cantons, it must be remarked that some of them were aristocracies and some democracies. In the former, both the legislative and executive power were lodged in the burghers or citizens of the capital of each canton; and of those there were seven, viz. Zurich, Berne, Basle, Friburg, Soleure, and Schaffhausen; an account of the most important of which may be seen under their respective names. In the others, the legislative power was lodged in the whole body of the people, and every male above 16, whether master or servant, had a vote in making laws and in the choice of magistrates. For what concerned the whole Helvetic body, there were diets ordinary and extraordinary; the former were held

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held annually, and the others on particular emergencies; and both were summoned by the city of Zurich, which appointed the time and place of their meetings. Besides the general diets, since the Reformation there were particular diets of the two religions, at which all public affairs of consequence that regarded the two parties were treated separately; for though a sense of their common interest obliged them to study the maintaining the league and union, yet it is certain that the mutual confidence between the cantons was in some measure lost through the zeal of each party for their particular opinions, especially of the Roman Catholics. The annual general diets were held always at Frauenfield or Baden, principally to regulate the affairs of the common baillages. Lucerne took the lead of the Roman Catholic cantons, being the most powerful of that denomination; but Zurich, though less powerful than that of Berne, took the precedence of all the other cantons, both Protestant and Popish. These cantons did not make one commonwealth, but were so many independent states, united together by strict alliances for their mutual defence. The extraordinary diets or congresses were held at Aldorf. Each canton usually deputed two envoys, both to the ordinary and extraordinary, to which also the abbot and the town of St Gal, and the town of Biel, sent representatives. To the 13 cantons belonged in common 21 baillages, 2 towns, and 2 lordships. The allies, as they were called, were the abbot and town of St Gal, the three Grison leagues, the republic of the Valais, the towns of Muhlhausen and Biel, the principality of Neuenburgh, Geneva, and the bishop of Basle. Of these, the abbot and town of St Gal, and the town of Biel, were regarded as members of the Helvetic body, but the rest only as allies.

The public revenues were in general very inconsiderable, and since the peace in 1815 have been computed at 430,000l sterling, arising chiefly from the usual regalia, appropriated every where to the sovereign, the demesnes, and public granaries, voluntary contributions, the sale of salt, and a land-tax; in the Protestant cantons, from the church lands also that were seized at the reformation. Except in Zurich, Bern, Basle, and Schaffhausen, where the people are more industrious, have a greater trade, and are richer than in the others, they defrayed only the ordinary charges.

The cantons never kept any standing troops except for a few garrisons; but their militia was reckoned to be the best regulated of any in Europe. Every male from 16 to 60 was enrolled, and about one-third of them formed into regiments. They were all obliged to provide themselves with arms, clothing, accoutrements, and to appear on the stated days for exercise; and the several cantons and districts were obliged to furnish themselves with a sufficient train of artillery, and all the other implements of war. The Swiss of the several cantons were allowed to engage in the service of such foreign princes and states as were in alliance with those cantons, or with whom they had made a previous agreement. Such states paying an annual subsidy to the respective cantons, were allowed to make levies. Every man enlisted voluntarily, for what number of years he pleased, at the expiration of which he was at liberty to return home. Many thus always returning from foreign service, Switzerland was never unprovided with able and experienced officers and soldiers.

11
Origin of the disputes between the cantons and the French republic.

It was scarcely to be expected that a country so long and so intimately connected with France, by its position, by perpetual alliance, by commerce, and partly by language, should escape the influence of the principles of its revolution, when states far more remote and distinct were strongly imbued with their spirit. But previous to the epoch of the French revolution, various parts of the Swiss confederation had been the seat of civil discord, and popular murmurs. In some cantons the indignant spirit of the subject had led him to revolt against what he deemed the oppresive administration of the ruler; in others, the distinctions which exist in society, and which form the different classes of privileged and unprivileged individuals, were strangely and inversely distributed. The French revolution, declaring the principle of equality, found a wide predisposition among the subjects of the Swiss confederacy to embrace the cause, and as strong a resistance on the part of the governors, who were deeply interested in opposing the progress of opinions so immediately subversive of authority. Conscious that with such a system no brotherhood could be cherished, many of the leading cantons kept themselves in a state of watchfulness, bordering on hostility, against the principles established by the French national assembly. But with so powerful a sanction, the frowns of power were ineffectual to calm the murmurs of discontent; and claims, which fear or policy had hitherto shut up in silence, were now produced, with confidence that they would be admitted from the sentiment of fear, if not of justice.

Among those who were most active in demanding a review of their grievances were the inhabitants of the French part of the canton of Berne, known by the name of the Pays-de-Vaud. The nobles and the higher classes of this province had long transmitted to their children a hereditary hatred of the government of Berne. This disaffection was not concealed; nor is it singular that the desire of change should operate on the titled and the rich, while they saw their political existence depending on the will of a self-elected sovereign, and their provinces subjected to the administration of an emissary of those whom they considered as usurpers of their rights.

But however strongly the sensibility of the subject inhabitants of the Pays-de-Vaud was excited by this political degradation, they were compelled to submit, or brood over their grievances in silence. They were incapable of procuring redress by force; and the sovereign burghers of Berne were too firmly seated to regard the remonstrances of impotent claimants, or to listen to the murmurs of discontent. Partial insurrections against the governments of certain cantons had often taken place in Switzerland. These disorders had sometimes been suppressed and punished with the interposition of the neighbouring cantons, where the danger was not excessive; but when these insurrections wore the serious characters of rebellion or revolt, the whole confederation marched against the conspirators. France before the revolution had even lent its aid to the suppression of those domestic quarrels, and had become the instrument of vengeance to the insulted sovereign; so that, whatever was the degree of oppression, or whatever the desire of resistance, redress was become hopeless, and change impossible.

It was chiefly among the classes of burghers and artizans who inhabited the towns, that discontent against the

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Switzerland.

the ruling power prevailed. The peasants, less oppressed, because more ignorant of their rights and privileges, not only did not themselves oppose the aggressions of the chief men in power, but even assisted them in quelling insurrections which arose among their rival classes.

All writers agree in the existence of vexatious and oppressive abuses among all the governments of the Swiss cantons, at the time of which we are now writing. The despotism of their institutions; the abuses of election to sovereign councils; the daily and encroaching spirit of authority; the overgrown influence of patrician families; the striking inequality which prevailed, even on this basis, of aristocratical power; the monopoly of places of profit to the exclusion of worth and talent; the undefined limits of proconsular administration; the want of encouragement to the arts and sciences; the neglect of education among those who were destined to rule, the void of which was filled up by idleness, arrogance, ignorance, and dissipation,—are so many features presented by writers of different characters and discordant sentiments, to fill up the picture of this vaunted region of happiness and liberty.

The severity exercised by the government of Berne over those inhabitants of the Pays-de-Vaud who had assembled on the 14th of July 1791, to commemorate the taking of the Bastile at Paris, and express their approbation of the French revolution, had created in the minds of the French people sensations of jealousy towards their Swiss neighbours; while the disbanding and dismissal of the Swiss regiments in the service of France, had contributed to exasperate the government of the cantons against the new republic.

All the cantons, except that of Berne, appeared for a long time disposed to preserve a neutrality towards revolutionary France; but that canton, under pretence of supporting the people of Geneva against the aggressions of the French, first displayed an avowed hostility, and marched a body of 15,000 troops towards the frontiers of the French republic. The true cause of this movement in the canton of Berne, has been by others stated to be the hopes entertained by some individuals of that government, of sharing in the plans of emolument and preferment which were expected to arise on the re-establishment of monarchy in France. The mutual jealousy subsisting between the Swiss cantons and the ruling power in France, was heightened by the protection given by some of the cantons to the French emigrants, and by the correspondence which others of the cantons had held with the bloody tribunal of Robespierre. After the retreat of the allied armies from the frontiers of France, the Swiss found it politic to make at least a show of amity towards the victorious republic; and accordingly recognised the existing government of the republic, and openly received M. Barthelemy as its *charge d'affaires*. Still, however, the sincerity of the cantons was justly doubted by the French directory, who appear to have long formed designs against the independence of Switzerland.

12 The Pays-de-Vaud occupied by the French, anno 1798.

The directory, confirmed in power, and relieved from the controul of a popular legislature, hastened, towards the close of the year 1797, to put in force their project of subjugating the Swiss republics. The first hostile movement on the part of the French, was to take possession of the Helvetic part of the bishopric of Basle, under some frivolous pretence, and contrary to an express treaty concluded with the Swiss in the year 1792. Either too weak or too prudent to resent this infraction of their rights, the Helvetic body still flattered themselves with an amicable termination of their difference with France; when an insurrection, which broke out in the *Pays-de-Vaud*, probably through French instigation, or at least through the influence of French principles, afforded a fuller pretext for the overthrow of the government. In the month of December, the French directory thought proper to interfere in this domestic dispute, and demanded from the government of Berne, what they termed the restoration of the rights of that people, and the assembling of the states of the Pays-de-Vaud in their ancient form. This demand they immediately prepared to enforce by arms; and General Menard was ordered to march, with a body of 15,000 men, to support the claims of the petitioning party in the Pays-de-Vaud. The designs of the French were for the moment frustrated by the timidity or generosity of the supreme council of Berne. On the 5th of January, 1798, they issued a proclamation, enjoining the citizens of the Pays-de-Vaud to assemble in arms, to renew the oath of allegiance, to proceed immediately to the reform of every abuse in the government, and to assert and re-establish all their ancient rights. A commission had been previously appointed at Lausanne, for determining on the claims of the petitioners, and for reinstating the conntry in its former tranquillity. From what causes it happened, we have not as yet been correctly informed, but the proceedings of the commission seemed involved altogether in embarrassment and delay. The people became impatient, and the insurrection at once broke out into actual hostility. The castle of Chillon was seized by the insurgents; and the commotions which took place in the southern districts of the province appeared no less formidable. The government of Berne now determined to reduce the insurgents by force; and a body of 20,000 troops, under the command of Colonel Weiss, was dispatched to disperse them. Whether the lenient measures pursued by this general, were consistent with sound policy or not, it is impossible, from the materials which have hitherto fallen under our inspection, to determine, Suffice it to say, that though it is not certain that more precipitate movements would have saved the country, yet his inactivity undoubtedly served to increase at once the power and the audacity of the insurgents. Thus situated, the approach of the French decided the contest. On passing the boundary, Menard dispatched an aide-de-camp, attended by two hussars, to General Weiss, at Yverdun; on their return, a fatal affray took place at the village of Thierens, in which one of the hussars was killed. Who were the aggressors in this unfortunate business is not correctly ascertained, but it was regarded by Menard as a declaration of war. His troops immediately advanced, while those of Weiss retreated, and the whole of the Pays-de-Vaud was, by the beginning of February, in the possession of the French.

The government of Berne still hoped, it appears, to avert the destruction which now seemed to await them; the centinels who had killed the hussar at Thierens were delivered up, and fresh negotiations were entered on. In the mean time, however, new insurrections were planned in different parts, and the revolutionary mania appeared to increase. In the seditious assemblages

Switzerland. on these occasions, the French envoy, Mengaud, was observed to take a decided part; and, on the 2d of January, he formally reclaimed some persons who had been arrested for treasonable practices by the government of Berne, as the friends and allies of the French republic. To this reclamation the government of Berne paid little attention; and the standard of revolt having been erected at Arau, they determined on effective measures for its suppression and their own defence. The Argovian militia marched to Arau; the town and province were immediately reduced, and the leaders of the insurrection were taken into custody.

13
Preparations for war on the part of the cantons.

War now appeared inevitable. To conciliate the minds of the people, and induce them more freely to lend their assistance, the government of Berne decreed, that 52 deputies from the principal towns and communes should be added to the supreme council; and, on the 2d of February, these new deputies took their seats. A general reform of all the abuses of the government was the first resolution agreed on in their deliberations; and the example of Berne was followed by the cantons of Lucerne, Fribourg, Soleure, Schaffhausen, and Zurich.

While, in this state of things, fresh negotiations were commenced with the French directory, a defensive force of about 20,000 men was collected. The other Swiss cantons dispatched their quotas to the defence of Berne, which amounted to about 5500 men. A truce had been concluded with the French general in the Pays-de-Vaud, where an officer of the name of Brune had succeeded Menard in the command. The truce was to have expired on the 1st of March; but General d'Erlach, fearful lest the spirit of his troops should slacken, demanded, on the 26th of February, positive orders to put his army in motion, and the council immediately made a decree to that effect. The plan of the campaign was now arranged by M. d'Erlach, and notice had been given to the posts that hostilities were to commence on the evening of the 1st of March; when the movements of the Swiss general were frustrated by the repeal of the decree which had been so hastily passed, and the negotiation was renewed with the French commander.

M. Mallet du Pan asserts, that the French general Brune, had agreed to prolong the truce for 30 hours; but, on the 2d March, the castle of Dornach, at the northern extremity of the canton of Soleure, was attacked and carried by the French; and at the same time, 13,000 men were marched under the walls of Soleure, which capitulated to General Schawenbourg on the first summons. Friburg was immediately after reduced by General Brune, and the Swiss army was forced to retreat.

While disaffection prevailed in the army of General d'Erlach, the inhabitants of Berne saw the rapid approach of the victorious army. On the 3d of March, the levy of the *Landsthurm*, or the rising of the people in a mass, was proclaimed. The expedient did not succeed in favour of the magistrates; the people were no sooner assembled in arms, than they of themselves dissolved the government; a provisional regency was elected for the occasion; the event was notified to General Brune; and to facilitate a pacification, an order was issued to dismiss the army, on condition that the French would keep the posts they at present occupied.

Unsatisfied with this concession, the French general insisted on the town receiving a French garrison. In the mean time all was confusion, both in Berne and in the army; the left division of which had mutinied, deserted their posts, and put to death some of their officers. By desertion, the Swiss army was now reduced to 14,000, to which might be added the undisciplined rabble which the Landsthurm had called forth. About 8000 of the regular forces were stationed at Neweneg, and 6400 held the position of Frauenbrun, against which General Schawenbourg advanced from Soleure, at the head of 18,000 men On the morning of the 5th March, both posts were attacked by the French, and a momentary success seemed to crown the valorous efforts of the division at Neweneg; but those stationed at Frauenbrun were, after a vigorous resistance, obliged to retreat; M. d'Erlach rallied his men at Uteren, where a second engagement took place, but with no better success on the part of the Swiss. At Grouholtz, however, they again made a stand, whence they were driven to the gates of the capital, where they were completely routed. The Swiss, in this engagement, lost 2000 in killed and wounded; while the loss of the French was about 1800. 14

Berne entered by the French.

On the evening of the 5th, General Brune entered the city of Berne by capitulation. The divisions of the Swiss army stationed at Neweneg and Guminen retreated; the soldiers of this last column, in despair, put their officers to death; and the unfortunate d'Erlach, in flying from the field of battle, was murdered by his countrymen and soldiers.

The submission of nearly the whole of Switzerland followed the defeat of the Bernese. The democratic republics, however, still made a glorious stand, defeated General Schawenbourg, and forced him to retire with the loss of 3000 men. 15

Helvetic republic formed.

The Swiss confederacy, after this revolution, changed its constitution, and even its name. Provisional governments, under the direction of the French generals, were established in the different districts, and the whole assumed the name of the Helvetic republic. Contributions were levied as usual, by the French commissioners; and some shocking enormities are reported to have been committed, chiefly by the army of the Rhine; for the divisions which belonged to the army of Italy are said to have conducted themselves with superior humanity and justice *. 16

Constitution of 1802.

In the beginning of 1802, a new constitution was framed for the Helvetic republic, under the direction of Bonaparte. Its leading features are as follows.

The Helvetic republic is one. Every citizen has a right of settling in any canton of the republic, and of exercising all the civil and political rights in the same manner as the citizens of the canton.

Berne is the capital of Helvetia. The Helvetic territory is divided into 21 cantons. The ecclesiastical property, in general, can be employed only for establishments of religious instruction, or of charity.

There is a central administration of the republic for the exercise of the national sovereignty, and an administration of the cantons. The administration of the cantons is composed of a diet and a senate. The diet is formed by the union of representatives from all the cantons, in the following proportions,—Berne, six; Zurich, two; Lucerne, five; Uri, one; Schweitz, three; Underwalden,

* See *New Annual Register* for 1798 and 1799.

Underwalden, one; Zug, one; Glaris, one; Soleure, two; Fribourg, three; Basle, two; Schaffhausen, one; Appenzel, one; St Gal, four; Turgovia, two; Argovia, two; Baden, two; Vaud, four; Grisons, one; Tessin, three; Valais, two. The members of the diet remain five years in office. The diet is to assemble regularly every year on the 1st of March. It shall be extraordinarily convoked by the senate when the majority of the cantons require it, or when itself shall judge that measure necessary. The president of the diet shall be the landamtman who is not in office. He has a casting vote, in case the votes shall be equally divided. A deputation of four members from the senate shall assist at the diet, but without having a right to vote.

The senate is composed of two landamtmans, two stadtholders or lieutenants, and 26 counsellors. Each canton must have at least one member in it. The senate forms the projects of laws and regulations, and submits them to the sanction of the cantons. The two landamtmans and their lieutenants have the direction of foreign affairs. The senate names and recalls diplomatic agents, on a proposition from the landamtmans.

Though France had not formally abolished the independent government of Switzerland, she exercised an influence in the affairs of the cantons, which left the diet little substantial power. From this influence Switzerland was delivered on the overthrow of the French power in 1814. The territories forced from her were restored, and Geneva was added to the list of cantons. Whether any change has subsequently been made in the internal or federative government we have not yet learned.

SWIVELS, a kind of ring made to turn round in a staple, or other ring. These are used when a ship lies at her moorings; also in tedders for cattle, that they may turn round without unwarping the tedder.

Swivel-Cannon, is a small piece of artillery belonging to a ship of war, which carries a shot of half a pound, and is fixed in a socket on the top of the ship's side, stern, or bow, and also in her tops. The trunnions of this piece are contained in a sort of iron crotch, of which the lower end terminates in a cylindrical pivot resting in the socket, so as to support the weight of the cannon. The socket is bored in a strong piece of oak, reinforced with iron hoops, in order to enable it to sustain the recoil. By means of this frame, which is called the *swivel*, and an iron handle on its cascable, the gun may be directed by the hand to any object. It is therefore very necessary in the tops, particularly when loaded with musket-balls, to fire down on the upper decks of the adversary in action.

SWOONING. See Medicine, N° 274.

SWORD, an offensive weapon worn at the side, and serving either to cut or stab. Its parts are, the handle, guard, and blade; to which may be added the bow, scabbard, pummel, &c.

Sword of State, which is borne before the king, lords, and governors of counties, cities, or boroughs, &c. For or before the king, it ought to be carried upright; the hilt as low as the bearer's waist, the blade up between his eyes. For or before a duke, the blade must decline from the head, and be carried between the neck and the right shoulder. For or before an earl, the blade is to be carried between the point of the shoulder and the elbow; and for or before a baron, the blade is to be borne in the bend of the arm. This ceremonial form no less denotes the dignity of a governor than the coronet set on his coat of arms.

Sword-Fish. See Xiphias, Ichthyology *Index*.

SWORN brothers (*fratres jurati*), persons who, by mutual oath, covenanted to share each other's fortune. Formerly, in any notable expedition to invade and conquer an enemy's country, it was the custom for the more eminent soldiers to engage themselves by reciprocal oaths to share the rewards of their service. This practice gave occasion to the proverb of *sworn brothers* or *brethren in iniquity*, because of their dividing plunder and spoil.

SYCAMORE-tree. See Acer, Botany *Index*.

SYCOPHANT, an appellation given by the ancient Athenians to those who informed of the exportation of figs contrary to law; and hence it is still used in general for all informers, parasites, flatterers, cheats, &c.

SYDENHAM, Dr Thomas, an excellent English physician, was the son of William Sydenham of Winford Eagle in Dorsetshire, and was born there about the year 1624. He studied at Magdalen-hall, Oxford; but left that university when Oxford was garrisoned for King Charles I. and went to London: where, becoming acquainted with Dr Thomas Cox, an eminent physician, that gentleman persuaded him to apply himself to the study of physic; accordingly, after the garrison was delivered up to the parliament, he retired again to Magdalene-hall, entered on the study of medicine, and in 1648 was created bachelor of physic. Soon after, he was made a fellow of All-Souls college, and continued there several years: when leaving the university, he settled at Westminster, became doctor of his faculty at Cambridge; grew famous for his practice; and was the chief physician in London from the year 1660 to 1670; at which period he began to be disabled by the gout. He died in 1689. His works are highly esteemed both at home and abroad. He was famous for his cool regimen in the small pox; for giving the bark after the paroxysm in agues; and for his use of laudanum. He regulated his practice more by his own observations and inquiries, than by the method either of his predecessors or contemporaries.

SYENE, an ancient city of Egypt, situated, according to Mr Bruce, in north latitude 24° 0′ 45″. Pliny and Strabo both say, that it lay directly under the tropic of Cancer. Whether Mr Bruce's authority be sufficient to overturn the evidence of Pliny and Strabo, we shall leave to others to determine.

Syene is remarkable for being the place where the first attempt was made to measure the circumference of the earth. This was done by Eratosthenes, whom Ptolemy Euergetes had invited from Athens to Alexandria. In this attempt two positions were assumed, viz. that Alexandria and Syene were exactly 5000 stadia distant from each other, and that they were precisely under the same meridian; but both these are denied by Mr Bruce, who has made many observations on the subject which our limits will not allow us to take notice of at present. He tells us, that there is at Asum an obelisk erected by Ptolemy Euergetes, the patron of Eratosthenes, without hieroglyphics, directly facing the south, with its top first cut into a narrow neck, then spread out like a fan into a semicircular form, with

Syene, Sylla. with pavements curiously levelled to receive the shade, and make the separation of the true shadow from the penumbra as distinct as possible. This is supposed by Mr Bruce to have been constructed with a design to vary the experiment of Eratosthenes with a larger radius; and the inquiry concerning the dimensions of the earth, in our author's opinion, was the occasion of many obelisks being erected in this kingdom; a demonstration of which is, that the figure of the top is varied; being sometimes very sharp, and sometimes a portion of a circle, in order to get rid of the great impediment arising from the penumbra, which makes it difficult to determine the length of the shadow with precision. It is now called *Assouan*.

SYLLA, Lucius Cornelius, was descended from the illustrious family of the Scipios. His behaviour in his younger years by no means corresponded with the excellent education which he had received. But debauchery, instead of bringing along with it infamy and ruin, its usual attendants, served only to increase the wealth of this fortunate Roman; for Nicopolis, a rich courtezan, whose affections he had gained, left him heir to her great estate.—He learned the art of war under Marius, whom he attended to Numidia in quality of questor. Though hitherto unaccustomed to arms, he became in a short time the most skilful soldier in the army, while by his polite and obliging behaviour he gained the love and esteem of every body. His courage and dexterity contributed a great deal towards the success of the war; it was his eloquence in particular that persuaded Bocchus to deliver up Jugurtha. He served afterwards in the Social war, where his actions entirely eclipsed those of every other commander. As a reward for this conduct he was raised to the prætorship. It is pretended by some that Sylla purchased this dignity; and that when he threatened one day to make use of the powers of *his* office against Strabo the father of Pompey, that Roman replied with a smile, "You are in the right to say so; your office is certainly *yours*, since you purchased it." Be this as it may, after the conclusion of the Social war he was made consul, and soon after declared general of the army which was to be sent against Mithridates king of Pontus. Marius, at that time the most renowned of the Roman generals, expected that the management of this war would have been committed to him, and was therefore much exasperated at the disappointment. The people were persuaded by his intrigues to reverse the former decree, and substitute him in place of Sylla. Upon this he sent down officers to take the command of the army; but Sylla by this time had gained over the soldiers; who, instead of obeying the decree of the people, slew Marius's officers, and intreated Sylla to lead them instantly to Rome. Accordingly he entered the city sword in hand, slew Sulpicius the consul, obliged Marius to flee, new-modelled the laws, and afterwards marched into the East, and immediately laid siege to Athens; for that city, together with the rest of Greece, had fallen into the power of Mithridates. He wrote to the Amphictyons, who were assembled at Delphi, to send him all the gold which was deposited in the temple of Apollo, because he stood in need of money; promising, at the same time, to restore it again at the end of the war. When he received this treasure, he observed, with an air of raillery, that he now no longer despaired of victory, since the gods themselves furnished him with money to pay his troops. Famine soon obliged the Athenians to think of a surrender. Their ambassadors waited on Sylla, and began to harangue about Theseus and Codrus, and Marathon and Salamis,—when he interrupted them, and exclaimed, "Go, repeat these fine orations in your schools; I have come hither, not to learn your history, but to chastise rebels." Athens was at last taken by assault, and Sylla was upon the point of destroying it, when he recollected its ancient glory, and spared (as he said) the living for the sake of the dead. After burning the Piræus, he gained two decisive victories over the generals of Mithridates. In the second battle, which was fought at Orchomenus, he was almost defeated; his troops began to flee, when, leaping from his horse, he snatched up a standard, and advanced against the enemy, crying out, "I will die here gloriously; and, soldiers, when you are asked where you abandoned your general, answer, At Orchomenus." This reproach recalled the courage of the Romans; they followed him to the charge, and gained a complete victory. Mithridates, humbled by these disasters, sent ambassadors to sue for peace.

Mean time Cinna had declared against Sylla in Italy; and Marius returning from banishment, had taken the most severe vengeance on all his enemies. Sylla was declared a traitor; his laws were reversed, his friends murdered, and the government new-modelled. The news of these transactions induced Sylla to conclude a treaty with Mithridates, and march directly to Rome. His approach terrified the Romans. Marius and Cinna were both dead; but the consuls made vigorous preparations to oppose him. A civil war was begun; but Sylla in the end subdued all his enemies, and entirely ruined the Marian faction. He entered Rome at the head of his victorious army, and publicly assumed the surname of *Happy*. Happy, indeed, had he ceased to live when he ceased to conquer. The remainder of his life contains nothing else but a catalogue of the most abominable cruelties. He declared that every one who expected a pardon for their late offences, must gain it by destroying the enemies of the state. The sword of the assassin was thus unsheathed, and murder encouraged as the path to power and distinction. The noblest of the Romans were everywhere massacred; slaves were rewarded for cutting off their masters; children were seen dragging their parents to execution; and brothers claiming a recompense for the murder of brothers. Sylla ordered 8000 wretches, who had thrown themselves upon his clemency, to be butchered in the Campus Martius. In the mean time he entered the senate-house, and began to talk with great coolness about his exploits. The senate, alarmed at the horrid outcries of the sufferers, at first thought that the city was given up to be plundered; but Sylla informed them, with an unembarrassed air, that it was only some criminals punishing by his orders, and that they needed not be apprehensive about their own fate.

To carry on these cruelties with the appearance of justice, he commanded the people to elect him dictator. He kept this office for more than two years; and then, to the amazement of all, laid it down, and offered to stand his trial before the people. Soon afterwards he retired into the country, and plunged headlong into every kind of debauchery. Nor did he relinquish his cruelty

cruelty together with his power: His wife falling ill in the midst of a sumptuous feast, he divorced her immediately; and ordered her to be carried away, lest her death should interrupt the festivity of his house.

He died of the morbus pedicularis, in the 60th year of his age. His body, according to his orders, was burnt. A little before his death he wrote his epitaph; the tenor of which was, that no man had ever exceeded him in doing good to his friends or injury to his enemies.

His person was elegant, his air noble, his manners easy and apparently sincere. He was fond of pleasure, but fonder of glory; indulging without scruple in sensual delights, but never suffering them to interrupt his serious business: He was eloquent, liberal, crafty, insinuating; a profound master of dissimulation; he spoke of himself with modesty, while he lavished praises on every other person: he stooped even to an acquaintance with the meanest soldier, and constantly adapted himself to the humours, pursuits, and opinions, of those with whom he conversed. Such was his character during the earlier part of his life; but when success had raised him above the necessity of dissimulation, he displayed a hideous train of vices, which his ambition had formerly taught him to conceal.—It was Sylla who recovered the works of Aristotle at the taking of Athens.

SYLLABLE, in *Grammar*, one or more letters pronounced by a single impulse of the voice, forming a complete sound, and constituting a word or a part of a word. No single letter can form a syllable except a vowel. The longest syllable in the English language is the word *strength*.

The most natural way of dividing words into syllables is, to separate all the simple sounds of which any word consists, so as not to divide those letters which are joined close together according to the most accurate pronunciation.

SYLLABUB, a kind of compound drink, most used in the summer season; ordinarily made of white wine, sugar, and nutmeg, into which is milked a quantity of new milk from the cow. Sometimes it is made of canary in place of white wine; in which case the sugar is spared, and a little lemon and nutmeg are added instead of it. To prepare it the best way, the wine and other ingredients, except the milk, are to be mixed over night, and the milk or cream added in the morning. The proportion, is a pint of wine to three of milk. For

SYLLABUB, *Whipt*. To half a pint of white wine or Rhenish is put a pint of cream, with the whites of three eggs. This they season with sugar, and beat with birchen rods, or work with a syringe. The froth is taken off as it rises, and put into a pot; where, after standing to settle two or three hours, it is fit to eat.

SYLLABUS, in matters of literature, denotes a table of contents, or an index of the chief heads of a book or discourse.

SYLLOGISM, in *Logic*, an argument or term of reasoning, consisting of three propositions; the two first of which are called *premises;* the last, the *conclusion*. See LOGIC, Part III.

SYLVIA, a genus of birds, belonging to the order of passeres, formed by Dr Latham by limiting the motacilla to the wagtail, and arranging the other species, formerly classed under that genus, under the sylvia. He making 13 species of the motacilla, and 175 species of the sylvia. See MOTACILLA, ORNITHOLOGY *Index*.

SYMBOL, a sign or representation of something moral, by the figures or properties of natural things. Hence symbols are of various kinds; as hieroglyphics, types, enigmas, parables, fables, &c.

SYMMACHUS, a citizen and senator of ancient Rome, and consul in the year 391, has left us ten books of epistles; from which, as well as from other things, we collect, that he was a warm opposer of the Christian religion. He was banished from Rome by Valentinian on some account or other, but afterwards recalled and received into favour by Theodosius. Ammianus Marcellinus speaks of him as a man of great learning and modesty. Scioppius, Pareus, and other learned men, have written notes upon the epistles of Symmachus: we know of no later edition of them than that of Frankfort, 1642, 8vo. Ambrose bishop of Milan wrote against Symmachus, and so did the Christian poet Prudentius.

SYMMETRY, the just proportion of the several parts of any thing, so as to compose a beautiful whole.

SYMMETRY, in *Painting*. See PAINTING, Part I. Sect. III.

SYMONDSBOROUGH, a remarkable large barrow of flints, near Wellington in Devonshire, in the northern extremity of Hemyock. The common people have a notion that a king called *Symon* was buried here. The tradition of the country plainly shows that it was the burial-place of some person or persons of eminence.

SYMPATHETIC, something that acts or is acted upon by sympathy. Thus we say, sympathetic diseases, inks, &c.

SYMPATHETIC Inks. See *Sympathetic* INK.

SYMPATHY, an agreement of affections and inclinations, or a conformity of natural qualities, humours, temperaments, which make two persons delighted and pleased with each other.

SYMPATHY, also denotes the quality of being affected by the affection of another; and may subsist either between different persons or bodies, or between different parts of the same body. It is either similar or dissimilar; similar, when the affection or action in the sympathiser is similar to the affection or action in the sympathant; and dissimilar, when those are different.—Sympathy too, is often an imitative faculty, sometimes involuntarily, frequently without consciousness: thus we yawn when we see others yawn, and are made to laugh by the laughing of another.

Sympathy, according to Dr Jackson *, relates to the operations of the affections of the mind, to the operations of the imagination, and to the affections of the external senses.

* *Treatise on Sympathy*.

1. The passions and affections of the mind produce in the body different sensations and impressions, and, as sympathies of consciousness, determine in general the spirits to those parts which labour most, or are most apt to be affected. Thus fear and anger determine to the heart; lust to the eyes, &c.; joy, pity, wonder, and the like to the head. See PASSION, page 14.

The affections of the mind of one person will often work upon the spirits of many. Thus whole companies are sometimes disposed to be sad and melancholy, or merry and jovial, when any one is present much inclined to either of those states of mind; and it has been observed, Sympathy. observed, that old people, who have loved the company of the young, and have been conversant continually with them, have generally lived long. But young people must not conclude from this, that the company and conversation of the grave and old will operate upon the living and sensitive principle, through the affections of their mind, and dispose them to be short-lived. On the contrary, by thus improving their understanding, they will be more enabled to fortify their constitution and resist the ravages of youthful indulgence.

It may also be further observed, that those tender sympathetic affections which lay hold of the mind, at the representation of theatrical performances, originate from the same principle, while they are to be considered as the surest test of just execution in the actor, and of the expressive language of the author. Indeed all stage effect depends on sympathy.

It has been said, that the passions of the mind are occasionally infectious, particularly some of them. Thus *fear* and *shame* are sometimes very suddenly so. We frequently may have occasion to see, that the starting of one will make another ready to start. Again, when one man is out of countenance in company, others will often blush in his behalf. However, the serious passions may surely be so under the controul of reason as to resist infection, whatever may be the case of temporary, muscular, or nervous attraction.

2. Our author is inclined to think, that a connection between the affections and sensations of the female mind and uterus, is very materially concerned in the process of generation, and probably can alone give efficacy to those actions and impressions subservient to conception, through the sympathizing affections of the mind. But this is a subject of which we know so little, that the speculations of even the most distinguished philosophers respecting it have been nothing but the wild ravings of imagination.

With respect to the depravity and force of the imagination in the production of sympathies, they always operate most upon "weak minds and spirits, and therefore most on women, superstitious and fearful persons, sick people, children, and young creatures." Their effects, however, sometimes fail to appear, because they are encountered and overcome by the mind and spirit before they work any manifest effects.

Such effects are obviated upon the same principle which establishes the prevention of bodily disease: "for in infection and contagion from body to body (as, for example, during the plague), the miasma may be received; but from the strength and good disposition of the body, it is expelled and wrought out before it has had sufficient time to form the disease."

It has been said, and many are of the opinion, that the force of imagination doth often forward the end proposed. Thus, for instance, it has been put as a question, "Whether a man, when he constantly and strongly believes that such a thing shall be (as that such a one will love him, and the like), helps any thing to the effecting the thing desired?" Certainly not in the manner which has been advanced, namely, "by a secret operation on the spirit of another." If he succeeds, it is either because he persevered, or because his perseverance and earnestness (and not any occult operation) makes him at length be attended to.

There is not a doubt but the force of imagination often gives energy to our actions. It may, however, unless we are much on our guard, easily delude us aside from reason. It has been the tree which has yielded the fruits of superstition in former times, and which has often fed the human mind with the most extravagant notions of sympathy. Sympathies of this kind, such as the power of charms, and the like, are now pretty generally exploded.

3. The five senses, *hearing*, *tasting*, *smelling*, *feeling*, and *seeing*, are conscious of a sympathetic impression from odious objects. "1. A disagreeable sound will set the teeth on edge, and make all the body shiver. 2. The swallowing of a nauseous medicine will be attended with a shaking of the head and neck. 3. Disagreeable smells produce nearly the same effect, which are less perceived, because there is a remedy at hand by stopping the nose. 4. If you come suddenly out of the sun into the shade, the sense of feeling is disturbed by a chillness or shivering of the whole body. 5. And even sudden darkness produces a propensity to shivering.

There is a very apparent reason why a sympathy should take place between the eyes. Hence their motions are synchronous. It may be said, that custom and habit dispose the eyes to move one and the same way; "for when one moveth towards the nose, the other eye moveth from the nose."

Though the eyes are by nature prone to move in concert, custom will, however, destroy this natural concert, and produce the contrary effect. Thus some people can squint when they will. Our author therefore gives this caution to mothers and nurses: "Let them not suffer infants to sit with a candle placed behind them; for both their eyes will be disposed to move outwards, as affecting to see the light of the candle, which may bring on the habit of squinting.

It appears as a quality in the senses of hearing and seeing, "that the instrument of each separate sense has a sympathy and similitude to that which giveth the reflection." Thus it has been observed, "that the eye will sympathize with a crystal glass or water, and the ear with caves and such hollow places as are suited to report echo."

Sympathies have been compared to unisons of sound in music. Unisons of sound produce agreeable sympathetic feelings; the reverse produce disagreeable feelings. "All concords and discords of music are (no doubt) sympathies and antipathies of sound." Moreover, "they are said to work as well by report of sound as by motion."

The most agreeable as well as odious objects operate in a secondary way, in producing those sympathetic impressions and actions which they commonly give rise to. An increased secretion of saliva often takes place at the sight of a favourite dish; and the running of water from a bottle, or otherwise, will sometimes affect individuals of a particular temperature, with an involuntary propensity to void urine.

Many have attempted to account for the remarkable sympathy which takes place between parts of the body seemingly unconnected with each other; but as these attempts are merely conjectures, without any solid principles to rest on, we pass them over as the dreams of ingenious men. It would be fortunate for science, if men would confine themselves to those subjects which can be known, Sympathy || Synagogue.

known, and never draw conclusions till they have established principles. See PHYSIOLOGY, chap. ii.

SYMPHONIA, a genus of plants belonging to the class of monadelphia. See BOTANY *Index*.

SYMPHONY, in *Music*, properly denotes a consonance or concert of several sounds agreeable to the ear, whether vocal or instrumental, called also *harmony*. See HARMONY.

SYMPHYSIS, in *Anatomy*, one of the kinds of junctures or articulations of the bones. See ANATOMY, N° 2.

Cutting the SYMPHYSIS of the Pubes. See MIDWIFERY, N° 136.

SYMPHYTUM, COMFREY, a genus of plants belonging to the class pentandria; and in the natural system ranging under the 41st order, *asperifoliæ*. See BOTANY *Index*.

SYMPLOCE, συμπλοκη, in *Rhetoric*, a figure, where the same word is repeated several times in the beginning and end of a sentence, including the ANAPHORA and EPITROPHE: thus, *Quis legem tulit? Rullus. Quis majorem populi partem suffragiis privavit? Rullus. Quis comitiis præfuit? Idem Rullus.*

SYMPLOCOS, a genus of plants belonging to the class polydelphia. See BOTANY *Index*.

SYMPOSIARCH, in antiquity, the director or manager of an entertainment. This office was sometimes performed by the person at whose charge the entertainment was provided; sometimes by another named by him; and at other times, especially in entertainments provided at the common expence, he was elected by lot, or by the suffrages of the guests.

SYMPTOM, in *Medicine*, any circumstance which indicates the existence, nature, or stage of a disease. Pain, waking, drowsiness, convulsions, suppression of urine, difficulty of breathing and swallowing, coughs, distastes, nauseas, thirsts, swoonings, faintings, looseness, costiveness, dryness and blackness of the tongue, are the principal *symptoms* of diseases. See MEDICINE, N° 41. and 58.

SYMPTOMATICAL, in *Medicine*, is a term often used to denote the difference between the primary and secondary causes in diseases: thus a fever from pain is said to be symptomatical, because it rises from pain only.

SYNÆRESIS, CONTRACTION, in *Grammar*, a figure whereby two syllables are united in one; as *vemens* for *vehemens*.

SYNAGOGUE, among the Jews, is a place where that people met to worship God. Authors are not agreed about the time when the Jews first began to have synagogues:—Some suppose them as old as the ceremonial law, and others fix their beginning to the times after the Babylonish captivity. They erected synagogues not only in towns and cities, but also in the country, especially near rivers, that they might have water for their purifications and ceremonious washings. No synagogue was built in any town unless there were ten persons of leisure in it; but there might be many in one town, or in one quarter of a town, provided it was very populous. Jerusalem is said to have contained 480. The chief things belonging to a synagogue were, 1. The ark or chest, made after the model of the ark of the covenant, containing the Pentateuch. 2. The pulpit and desk in the middle of the synagogue, in which he that was to read or expound the law stood. 3. The seats or pews for the people. 4. The lamps to give light at evening service, and the feast of dedication. 5. Rooms or apartments for the utensils and alms chest. The synagogue was governed by a council or assembly, over whom was a president, called *The Ruler of the Synagogue*. These are sometimes called *Chiefs of the Jews*, *The Rulers*, *The Priests* or *Elders*, *The Governors*, *The Overseers*, *The Fathers of the Synagogue*. Their business was to punish the disobedient, by censures, by excommunication, or by penalties, such as fines and scourging; to take care of the alms, which are frequently called by the name of righteousness. The chief ruler, or one of the rulers, gave leave to have the law read and expounded, and appointed who should do it. In every synagogue, there were several ministers who had different offices assigned to them. Service was performed three times a-day, viz. in the morning, in the afternoon, and at night; at the time of morning sacrifice, evening sacrifice, and after the evening sacrifice on Mondays, Thursdays, and Saturdays, there was a more forcible obligation upon the people to attend than upon the other days. There are synagogues at London, Amsterdam, Rotterdam, Avignon, Metz, &c.

Wilson's Archæological Dictionary.

Synagogue || Syncopation.

SYNALOEPHA, in *Grammar*, a contraction of syllables, performed principally, by suppressing some vowel or diphthong at the end of a word, on account of another vowel or diphthong at the beginning of the next. As, *ill' ego*, for *ille ego*, &c.

Conticuer' omnes intentiqu' ora tenebant. VIRG.

It is called by the Latins *collisio*.

SYNARTHROSIS. } See ANATOMY, N° 2.
SYNCHONDROSIS. }

SYNCELLUS, or SINCELLUS, an ancient officer in the family of the patriarchs, and other prelates of the eastern church. The word, in the corrupt Greek, συγκηλλος, signifies a person who lies in the chamber with another; a *chamber-fellow*, or *chum*. The syncellus was an ecclesiastic, who lived with the patriarch of Constantinople, to be a witness of his conduct; whence it is, that the syncellus was also called the *patriarch's eye*, because his business was to observe and watch. The other prelates had also their syncelli, who were clerks living in the house with them, and even lying in the same chamber, to be witnesses of the purity of their manners. Afterwards the office degenerated into a mere dignity; and there were made syncelli of churches.—At last, it became a title of honour, and was bestowed by the emperor on the prelates themselves; whom they called *pontifical syncelli*, and *syncelli Augustales*.

SYNCHRONISM denotes the happening of several things at the same time. See CHRONOLOGY.

SYNCOPATION, in *Music*, denotes a striking or beating of time, whereby the distinction of the several times or parts of the measure is interrupted. However, it is more properly used for the connecting the last note of any measure, or bar, with the first of the following measure, so as only to make one note of both. A syncope is sometimes also made in the middle of a measure. Syncopation is also used when a note of one part ends or terminates on the middle of a note of the other part. This is otherwise denominated *binding*. It is likewise used for a driving note; that is, when some shorter note at the beginning of a measure, or half measure, is followed

lowed by two, three, or more longer notes before another short note occurs, equal to that which occasioned the driving, to make the number even, e. gr. when an odd crotchet comes before two or three minims, or an odd quaver before two, three, or more crotchets. In syncopated or driving notes, the hand or foot is taken up, or put down, while the note is sounding.

SYNCOPE, FAINTING; a deep and sudden swooning, during which the vital functions are suspended. See MEDICINE, N° 98. and 272.

SYNCOPE, in *Grammar*, an elision or retrenchment of a letter or syllable out of the middle of a word, as *caldus* for *calidus*.

SYNDIC, in government and commerce, an officer, in divers countries, intrusted with the affairs of a city or other community, who calls meetings, makes representations and solicitations to the ministry, magistracy, &c. according to the exigency of the case.

SYNECDOCHE, in *Rhetoric*, a kind of trope frequent among orators and poets. See ORATORY, N° 56.

SYNECPHONESIS, in *Grammar*, a coalition, whereby two syllables are pronounced as one; being much the same as SYNALOEPHA and SYNÆRESIS.

SYNEUROSIS. See ANATOMY, N° 2.

SYNGENESIA, (συν and γενεσις, "congeneration)," the name of the 19th class in Linnæus's artificial system. See *Classification*, BOTANY *Index*.

SYNGNATHUS, PIPE-FISH, a genus of fishes belonging to the cartilaginous order. See ICHTHYOLOGY, page 104.

SYNOCHA, and SYNOCHUS, in *Medicine*, the names of two species of continued fever. See MEDICINE, N° 164.

SYNOD, in *Astronomy*, a conjunction or concourse of two or more stars or planets, in the same optical place of the heavens.

SYNOD signifies also a meeting or assembly of ecclesiastical persons to consult on matters of religion.

Of these there are four kinds, viz. 1. *General*, or *œcumenical*, where bishops, &c. meet from all nations. These were first called by the emperors, afterwards by Christian princes; till in later ages the pope usurped to himself the greatest share in this business, and by his legates presided in them when called. 2. *National*, where those of one nation only come together, to determine any point of doctrine or discipline. The first of this sort which we read of in England, was that of Herudford or Hertford, in 673, and the last was that held by Cardinal Pole, in 1555. 3. *Provincial*, where those only of one province meet, now called the *convocation*. 4. *Diocesan*, where those of but one diocese meet, to enforce canons made by general councils, or national and provincial *synods*, and to consult and agree upon rules of discipline for themselves. These were not wholly laid aside, till by the act of submission, 25 Hen. VIII. c. 19. it was made unlawful for any *synod* to meet, but by royal authority. See COUNCIL and CONVOCATION.

SYNODS, *Provincial, in the Government of the Church of Scotland* See PRESBYTERIANS, N° 14.

SYNODALS, or SYNODIES, were pecuniary rents (commonly of two shillings), paid to the bishop, or archdeacon, at the time of their Easter visitation, by every parish priest. They were thus called, because usually paid in synods: because anciently bishops used to visit and hold their diocesan synods once.—For the same reason, they are sometimes also denominated *synodalica;* but more usually, *procurations*.

SYNODICAL, something belonging to a synod. Thus, synodical epistles are circular letters written by the synods to the absent prelates and churches; or even those general ones directed to all the faithful, to inform them of what had passed in the synod.

SYNOECIA, in Grecian antiquity, a feast celebrated at Athens in memory of Theseus's having united all the petty communities of Attica into one single commonwealth; the seat whereof was at Athens, where all the assemblies were to be held. This feast was dedicated to Minerva; and, according to the scholiast on Thucydides, it was held in the month *Metagitnion*.

SYNONYMOUS, is applied to a word or term that has the same import or signification with another.

Several works have been composed for the express purpose of explaining synonymous words. In 1777 a work was published on the Latin synonyma at Paris by M. Gardin Dumesnil. The abbé Girard published one on the synonymous terms of the French language many years ago. Another was published on the same subject in the year 1785 by the abbé Roubaud. An account of the English synonyma was published by an anonymous author in 1766; which is a close imitation, and in some parts a literal translation, of the abbé Girard's *Synonymes François*. Mrs Piozzi has written some essays on the same subject.

SYNOVIA, in *Medicine*, a term used by Paracelsus and his school for the nutritious juice proper and peculiar to each part. Thus they talk of the synovia of the joints, of the brain, &c.

SYNTAX, in *Grammar*, the proper construction or due disposition of the words of a language into sentences and phrases. See GRAMMAR and LANGUAGE.

SYNTHESIS, in *Logic*, denotes a branch of method, opposite to analysis.

In the synthesis or synthetic method, we pursue the truth by reasons drawn from principles before established or assumed, and propositions formerly proved: thus proceeding by a regular chain, till we come to the conclusion. Such is the method in Euclid's Elements, and most demonstrations of the ancient mathematicians, which proceed from definitions and axioms, to prove propositions, &c. and from those propositions proved to prove others. This method we also call *composition*, in opposition to *analysis* or *resolution*. See ANALYSIS.

SYPHILIS. See MEDICINE, N° 350.

SYPHON. See HYDRODYNAMICS. Some uncommon phenomena in nature may be accounted for upon the principles of the syphon; as, for instance, that of reciprocating springs. See PNEUMATICS, N° 373.

SYRACUSE, a celebrated city of Sicily, and once the capital of the island. It was built, according to Thucydides and Strabo, by Archias, one of the Heraclidæ, who came from Corinth into Sicily in the second year of the 11th Olympiad, and derived its name from a neighbouring marsh named *Syraco*. What form of government first prevailed in the city is not known. Many have supposed it originally to have been governed by kings: but if this were the case, the monarchical government continued only for a very short time; since Aristotle, Diodorus Siculus, and Justin, mention it as being very early subject to a democracy. The history is

1 At what time built.

Syracuse. is obscure and unimportant till the time of Gelon, when Syracuse first began to make a conspicuous figure.

2 Gelon seizes on the sovereignty. Gelon was born in the city of Gela in Sicily, of the family of Telines, who had been created priest of the infernal gods. He signalized himself in a war carried on against the Syracusans, by Hippocrates tyrant of Gela, whom he defeated in a pitched battle. Having thus become very powerful among his countrymen, he soon found means to seize on the sovereignty for himself. In a short time, having put himself at the head of some Syracusan exiles, he marched towards that place, where he was received with loud acclamations and obtained possession of the city.

Gelon, in order to people the capital of his new dominions, first demolished the neighbouring city of Camarina, and transplanted the inhabitants to Syracuse. Soon after, entering into a war with the Megareans, he defeated them, took and rased their cities, and in like manner transplanted the people. Syracuse thus became powerful, and full of inhabitants; and the friendship of Gelon was courted both by Athens and Lacedæmon at the time of the Persian invasion. In the mean time the Carthaginians had entered into a treaty with the Persians; by which it was agreed, that the former should attack those of the Greek name in Sicily and Italy, in order to divert them from assisting each other.

3 Defeats the Carthaginians, and takes the title of king. Sicily was accordingly invaded by the Carthaginians with a vast army; but they were utterly overthrown by Gelon, as is related under the article CARTHAGE, N° 7—9. After this victory, the people out of gratitude obliged him to assume the title of king; which till that time he had refused. A decree also passed by which the crown was settled on his two brothers Hiero and Thrasybulus after his death.

4 His excellent reign. The new king, instead of keeping his subjects in greater awe, studied to make them happy, and was the first man who became more virtuous by being raised to a throne. He was particularly famous for his honesty, truth, and sincerity; is said never to have wronged the meanest of his subjects, and never to have promised a thing which he did not perform.

5 Gelon dies, and is succeeded by Hiero. An. 471: B. C. Gelon died in the year 471 B. C. after having reigned three or four years; and was succeeded by his brother Hiero, whose character is differently drawn by different historians. He is highly celebrated in the odes of Pindar; and it is certain that his court was the resort of men of wit and learning, to whom he behaved in the most courteous manner and with the greatest liberality.

6 Thrasybulus, a tyrant. An. 459. In 459 B. C. Hiero was succeeded by Thrasybulus; who proving a tyrant, was in ten months driven out, and a popular government restored; which continued for the space of 55 years.

7 The Siculi subdued. About this time the Syracusans entered into a war with the Siculi, which terminated in the total subjection of the latter; after which Syracuse became so powerful, that it in a manner gave law to the whole island. The Greek cities indeed enjoyed a perfect liberty; but they all acknowledged Syracuse as their metropolis: by degrees, however, the latter began to assume such an authority over them as was totally inconsistent with liberty; and this occasioned many wars, which involved them in much distress and danger. They began with the Leontines, whose territory they laid waste, and reduced their city to great straits. Leontini was an Athenian colony: and this furnished the Athenians,

8 Syracuse invaded by the Athenians without success.

who had already meditated the conquest of Sicily, with a pretence to attack the Syracusans with their whole force. Under colour of assisting their countrymen, therefore, they sent a fleet of 250 sail to Sicily; but the Leontines, sensible that their pretended allies aimed at nothing less than the conquest of the whole island, concluded a peace with Syracuse; and the disappointed Athenians vented their rage on those who had advised and conducted the expedition.

During the continuance of the popular government, the Syracusans took part in the long war between Athens and Sparta. The circumstances which took place in this contest are sufficiently detailed under ATTICA, N° 126—150.

This war was scarcely ended, when a new and formidable invasion by the Carthaginians took place; but the event of that expedition was as unfortunate to the Carthaginians as the former had been, as has been particularly related under the article CARTHAGE, N° 12. *et seq.* 9 New invasion by the Carthaginians.

In the mean time, a considerable revolution had happened in Syracuse. The city of Agrigentum had been taken by the Carthaginians, and of the few inhabitants who escaped, some fled to Syracuse, where they accused the Syracusan commanders of having betrayed the city into the hands of the enemy. Dionysius, a man of great valour and address, but who had become very obnoxious to the populace, took this opportunity of attempting to retrieve his credit. He therefore supported the accusations brought against his countrymen by the Agrigentines, and even impeached the magistrates as having a secret intelligence with the enemy, and attempting to introduce an oligarchy. As his speech was entirely levelled against the more wealthy citizens, it was very agreeable to the lower class: the commanders were instantly degraded; and others, among whom was Dionysius, were appointed. Having once gained this point, he began to consider how he might get all his colleagues turned out. For this purpose he never joined in any council of war with the other commanders, nor imparted to them his resolutions, giving out that he could not trust them, and that they had more regard for their own interest than the welfare of their country. But while he was proceeding in this manner, the more prudent part of the citizens, perceiving what he aimed at, complained of him to the senate and magistrates, and fined him as a disturber of the public peace. According to the laws, the fine was to be paid before he could speak in public, and the circumstances of Dionysius did not allow him to discharge it. In this dilemma he was assisted by Philistus the historian, a man of great wealth, who not only paid this fine for him, but encouraged him to speak his mind freely, as it became a zealous citizen to do, promising to pay all the fines that should be laid upon him. 10 Rise of Dionysius.

Being extricated out of this difficulty, Dionysius next proceeded to inveigh, with all the eloquence of which he was master, against those who by means of their power or interest were able to oppose his designs, and by degrees brought them into discredit. His next scheme was to get those exiles recalled whom the nobility had banished at different times; as thinking that they would support him with all their power, as well out of gratitude as out of hatred to the opposite party. Having gained this point also, he next found means to ingratiate him-

Syracuse. self with the soldiery to such a degree, that, under pretence of taking proper measures for resisting the Carthaginians, he was chosen commander in chief, with absolute and unlimited power. This was no sooner done, than, pretending his life was in danger, he chose out 1000 men for his guard, whom he attached to his interest by great promises. As no person durst now oppose him, he possessed himself of the capital, where all the arms and provisions were kept; after which he publicly took the title of king of Syracuse in the year 404 B. C.

11 who becomes king of Syracuse. An. 404. B. C.

The Syracusans did not tamely submit to their new master: but Dionysius managed matters so well, that their frequent revolts answered no other purpose than more certainly to entail slavery on themselves; and he was allowed to possess the throne without much opposition till his death, which happened in the year 366 B. C.

12 Dionysius II. An. 366. B. C.

On the death of Dionysius, he was succeeded by his son, called also Dionysius. He was naturally of a mild and peaceable temper, averse to cruelty, and inclined to learning; but his father, to whom all merit, even in his own children, gave umbrage, stifled as far as possible his good qualities by a mean and obscure education. He no sooner ascended the throne, than Dion, brother to Aristomache the other wife of Dionysius the Elder, undertook to correct the faults of his education, and to inspire him with thoughts suitable to the high station in which he was placed. For this purpose he sent for the philosopher Plato, under whose care he immediately put the young king. This instantly produced a reformation on Dionysius; but the courtiers, dreading the effects of the philosopher's instructions, prevailed on him to banish Dion, and to keep Plato himself in a kind of imprisonment in the citadel. At last, however, he set him at liberty; upon which Plato returned to his own country.

13 Put under the care of Plato by his uncle Dion, whom he banishes.

Dion, in the mean time, visited several of the Grecian cities, and at last took up his residence in Athens; but the honours which were everywhere paid him, raised such jealousies in the breast of the tyrant, that he stopped his revenue, and caused it to be paid into his own treasury. In a short time Dionysius again sent for Plato; but finding it impossible to dissolve the friendship between him and Dion, disgraced, and placed him in a very dangerous situation, in the midst of assassins who hated him. Not daring, however, to offer him any violence, he allowed him soon after to depart; revenging himself on Dion, whose estate he sold, and gave his wife Arete in marriage to Timocrates one of his flatterers.

Dion now resolved to revenge himself on the tyrant for the many injuries he had sustained, and at once to deliver his country from the oppression under which it groaned. He began with raising foreign troops privately, by proper agents, for the better execution of his design. Many Syracusans of distinction entered into his scheme, and gave him intelligence of what passed in the city; but of the exiles, of whom there were upwards of 1000 dispersed up and down Greece, only 25 joined him; so much were they awed by the dread of the tyrant. The troops were assembled at the island of Zacynthus, in number only about 800; but who had all been tried on many occasions, were well disciplined, and capable of animating by their example the forces which Dion hoped to find in Sicily. When they were about to sail, Dion acquainted them with his design, the boldness of which at first occasioned among them no small consternation; but Dion soon removed their fears, by telling them that he did not lead them as soldiers, but as officers, to put them at the head of the Syracusans and all the people of Sicily, who were ready to receive them with open arms. Having then embarked in two small trading vessels, they arrived in 12 days at Cape Pachynum near Syracuse. At last they arrived at the port of Minoa, not far from Agrigentum. Here they received intelligence that Dionysius had set sail for Italy, attended by a fleet of 80 galleys. On this Dion resolved to take advantage of the tyrant's absence, and immediately set sail for Syracuse. On his march he prevailed on the inhabitants of Agrigentum, Gela, Camarina, and other cities, to join him. As soon as he entered the territories of Syracuse, multitudes flocked to him; and as nobody appeared to oppose him, he boldly entered the city, where he quickly found himself at the head of 50,000 men. As soon as he had landed in Sicily, Timocrates, to whom his wife Arete had been given by Dionysius, and to whom the care of the city had been left, dispatched a courier to let the tyrant know the danger in which he was. Dionysius was, however, accidentally prevented from receiving a timely account of Dion's arrival; so that when he entered the citadel by sea, seven days after Dion's arrival, he found his affairs in a desperate situation. Upon this he had recourse to artifice; and having amused the Syracusans by a feigned negociation, until he observed that they kept a negligent guard, he attacked them all at once with such fury, that he had almost taken the city. But Dion encouraged the soldiers by his example so much, that he at last obtained a complete victory; for which they presented him with a crown of gold.

14 Dion raises troops for dethroning the tyrant.

15 Enters Syracuse without opposition.

16 Dionysius arrives, but is totally defeated.

It was not long, however, before the ungrateful Syracusans began to think of conferring quite different rewards on their benefactor. Dionysius had the address to render him suspected by the multitude; at the same time that Heraclides, an excellent officer, but a secret enemy to Dion, did all that lay in his power to sink his credit. Dionysius was soon obliged to fly into Italy, but left Heraclides to oppose Dion.

17 Ingratitude of the Syracusans to Dion.

At length Dion got possesion of the city, Heraclides submitted to him, and was received into favour; but as his seditious and turbulent behaviour still continued, Dion at last gave orders to put him to death. This action, however necessary, so affected the mind of Dion, that he became melancholy; and ever after imagined himself haunted by a frightful spectre, resembling a woman of gigantic stature, with the haggard looks and air of a fury. In a short time after he lost his life, through the base treachery of Calippus, or Gylippus, who pretended to be his intimate friend, and who immediately after caused his wife and sister to be carried to prison.

18 Dion becomes melancholy, and is murdered.

Calippus having removed Dion, soon made himself master of Syracuse, where he committed all manner of cruelties; but was driven out, and forced to fly to Rhegium, where he was murdered by the same dagger which had killed Dion. In 350 B. C. Dionysius again made himself master of Syracuse; and being exasperated by his past misfortunes, tyrannized worse than ever. The Syracusans first had recourse to Icetas tyrant of Leontini; but as the Carthaginians took this opportunity to invade

19 Dionysius restored.

Syracuse. vade them with a powerful fleet and army, they were obliged to apply to the Corinthians. By them Timoleon, a celebrated commander, was sent to the assistance of the Syracusans, whom he found in a very distressed situation; Icetas being master of the city, the Carthaginians of the harbour, and Dionysius of the citadel.

20 Surrenders to Timoleon, and keeps a school at Corinth. As all parties were equally the enemies of Dionysius, he found it impossible to hold out, and therefore surrendered himself to Timoleon, by whom he was sent to Corinth; where at last he was reduced to the necessity of teaching a school for his support.

After the expulsion of the tyrant, Timoleon withdrew to Catana, leaving only 400 Corinthians, under the command of an experienced officer named *Leon*, to guard the citadel. These were immediately besieged by Icetas and the Carthaginians, but Timoleon found means to relieve them in spite of all opposition; and having dispersed emissaries through the army of Mago the Carthaginian general, exhorting the mercenary Greeks to forsake him, he was so much intimidated, that in spite of all the remonstrances Icetas could make, he set sail for Africa, leaving his colleague to carry on the war in the best manner he could.

21 Cowardice of the Carthaginians.

The day after the departure of Mago, Timoleon assaulted the city so briskly, that the troops of Icetas were driven from the walls, and the Corinthians became masters of the place. Timoleon, by sound of trumpet, invited the inhabitants to come and assist in demolishing the citadel and other castles, which he called the *nests of tyrants:* after which he caused edifices to be erected in the place where the citadel had stood, for the administration of justice. He found the city in a most miserable situation: for many having perished in the wars and seditions, and others having fled to avoid the oppression of tyrants, Syracuse, once so wealthy and populous, was now become almost a desert; insomuch that the horses were fed on the grass which grew on the market-place. Timoleon supplied the city with inhabitants from Corinth and other cities of Greece, at the same time that great multitudes from Italy and the other parts of Sicily resorted thither. Timoleon distributed the lands among them *gratis;* but sold the houses, and with the money arising from the sale established a fund for the support of the poor. Having thus restored Syracuse, he in like manner delivered all the Greek cities of Sicily from the tyrants who had taken possession of them, all of whom he put to death. After this he resigned his authority, and led a retired life, honoured in the highest degree by the Syracusans, and by all the cities in Sicily. After his death he was honoured as a god; the expence of his funeral was defrayed by the public; sports, with horse-races and gymnastic exercises, were held annually on the day of his death; and it was decreed, that whenever the Syracusans were at war with the barbarians, they should send to Corinth for a general.

22 Citadel of Syracuse and other forts demolished by Timoleon.

23 He repeoples the city.

24 Dies, and is honoured as a god.

25 Syracuse again falls under the power of tyrants.

For 20 years the Syracusans enjoyed the fruits of Timoleon's victories; but new disturbances arising, in a short time another tyrant started up, who exceeded all that had gone before him in cruelty and other vices. This was the celebrated Agathocles, of whose exploits against the Carthaginians a full account is given under the article CARTHAGE, N° 33—53. He was poisoned by one Mœnon in the year 289 B. C. after having reigned 28 years, and lived 95.—A succession of tyrants followed, till at last the city, being held by two rivals, Tœnion and Sosistratus, who made war within the very walls, Pyrrhus king of Epirus was invited into Sicily, in order to put an end to these distractions. He willingly complied with the invitation; and was everywhere received with loud acclamations, as the deliverer not only of Syracuse, but of all Sicily. As he had a fine army of 30,000 foot and 5000 horse, with a fleet of 200 sail, he drove the Carthaginians from place to place, till he left them only the two strong posts of Eryx and Lilybæum. The former of these he took by assault, and was himself the first man who mounted the walls, after having killed a great number of Africans with his own hand. The Mamertines likewise, who had conquered a considerable part of the island, were everywhere defeated and driven out, till at last they were shut up in the city of Messana. The Carthaginians, alarmed at the rapidity of his conquests, sent ambassadors with proposals of peace upon very advantageous terms; but Pyrrhus, puffed up with the expectation of reducing the whole island, refused to hearken to any terms unless they would instantly abandon it. So firm was he in the belief of this, that he caused his son to assume the title of *king of Sicily;* but in the mean time, having displeased the Sicilians by his arbitrary behaviour, they deserted from him in such numbers that he was glad to set out for Italy, for which retreat the embassies he received from the Samnites, Tarentines, and other Italians, furnished him with an honourable pretext. He embarked in the ships which he had brought with him from Italy; but was met at sea by the Carthaginians, who sunk 70 of his vessels, and dispersed or took the rest; so that he saved himself in Italy with only 12 vessels, the poor remains of a fleet of 200 sail. No sooner were the Mamertines apprised of his departure, than they dispatched a body of 18,000 men to harass him after his landing. These having passed the straits before him, posted themselves in the road which Pyrrhus must take in marching by land to Tarentum; and concealing themselves among woods and rocks, attacked him unexpectedly, and with great resolution. But Pyrrhus behaved on this occasion with his usual bravery. The attack being made on his rear, he hastened thither, and made a dreadful slaughter of the enemy, till a wound on his head obliged him to retire.

Syracuse.

26 Pyrrhus king of Epirus invited into Sicily.

27 Syracuse harassed by the Mamertines.

28 Hiero chosen general of the Syracusan forces.

After the departure of Pyrrhus, Hiero the son of Hierocles, a descendant of Gelon, the first king of Syracuse, was chosen general of the forces, along with another named *Artemidorus.* The two generals had nothing more at heart than to put an end to the confusion and disorder which reigned in the city; for which reason they entered it at the head of their forces. On this occasion Hiero discovered extraordinary talents for government. By mere dint of insinuation and address, without shedding blood, or hurting a single citizen, he calmed the minds of the people; reconciled the factions; and so gained the affections of all, that he was invested with the whole civil as well as military power in the state. Soon after this, he married the daughter of one of the first citizens; and having distinguished himself by his exploits against the Mamertines, was unanimously elected king of Syracuse, in the year 265 B. C.

29 Is elected king of Syracuse. An. 265. B. C.

Some time after Hiero's accession to the throne, he again defeated the Mamertines, and reduced them to such straits, that they were obliged to call in the Ro-

mans

Syracuse. mans to their assistance. The consequences of this have been fully related under the articles ROME and CARTHAGE. Hiero, who had allied himself with the Carthaginians, being himself defeated by the Romans, and finding his allies unable to protect him against the power of that republic, concluded an alliance with them; and continued faithful to them even in the time of the second Punic war, when they were in the greatest distress. In his reign flourished the celebrated mathematician Archimedes, whose genius he employed in fortifying the city of Syracuse, by innumerable machines, in such a manner as rendered it absolutely impregnable to every method of attack known at that time.

30 Hieronymus allies with the Carthaginians.

Hiero died about 211 B. C. and was succeeded by his grandson Hieronymus: but he imprudently forsook the counsels of his grandfather, and entered into an alliance with the Carthaginians. Soon after this he was murdered, in consequence of his tyranny and cruelty, and the greatest disorders took place in the city; which Hannibal, though then in Italy, found means to foment, in hopes of keeping the Syracusans in his interest. This indeed he effected; but as his own affairs in Italy began to decline*, he could not prevent Marcellus from landing in Sicily with a formidable army, which the Sicilians could by no means resist. Syracuse was soon invested; but the machines invented by Archimedes baffled all attempts to take it by assault. The immense preparations which the consul had made for taking the city by storm, could not have failed to accomplish his purpose, had the place been otherwise defended than by the contrivance of Archimedes. The Roman fleet consisted of 60 quinqueremes, besides a far greater number of other ships. The decks were covered with soldiers armed with darts, slings, and bows, to drive the besieged from the ramparts, which on one side were washed by the sea, and to facilitate the approach to the walls. But a machine of Marcellus's own invention, called a *sambuca*, was what he chiefly depended on. The consul's design was to bring his sambuca to the foot of the walls of Acradina; but, while it was at a considerable distance (and it advanced very slowly, being moved only by two ranks of rowers), Archimedes discharged from one of his engines a vast stone, weighing, according to Plutarch's account, 1250 pounds, then a second, and immediately after a third; all which, falling upon the sambuca with a dreadful noise, broke its supports, and gave the galleys upon which it stood such a violent shock that they parted, and the machine which Marcellus had raised upon them at a vast trouble and expence was battered to pieces. At the same time, several other machines, which were not visible without the walls, and consequently did not lessen the confidence of the Romans in the assault, played incessantly upon their ships, and overwhelmed them with showers of stones, rafters, and beams pointed with iron; insomuch that Marcellus, being at a loss what to do, retired with all possible haste, and sent orders to his land-forces to do the same; for the attack on the land-side was attended with no better success, the ranks being broken and thrown into the utmost confusion by the stones and darts, which flew with such noise, force, and rapidity, that they struck the Romans with terror, and dashed all to pieces before them.

* See *Carthage*, N° 123.

31 Syracuse invested.

32 Incredible effects of the machines of Archimedes.

Marcellus, surprised, though not discouraged, at this artificial storm, which he did not expect, held a council of war, in which it was resolved, the next day before sunrise, to come up close under the wall, and keep there. They were in hopes by this means to secure themselves against the terrible storm of stones and darts which fell on the ships when at a distance. But Archimedes had prepared engines which were adapted to all distances. When the Romans therefore had brought their ships close under the wall, and thought themselves well covered, they were unexpectedly overwhelmed with a new shower of darts and stones, which fell perpendicularly on their heads, and obliged them to retire with great precipitation. But they were no sooner got at some distance, than a new shower of darts overtook them, which made a dreadful havock of the men, while stones of an immense weight, discharged from other machines, either disabled or broke in pieces most of their galleys. This loss they sustained, without being able to revenge it in the least on the enemy. For Archimedes had placed most of his engines behind the walls, and not only out of the reach, but even out of the sight, of the enemy; so that the Romans were repulsed with a dreadful slaughter, without seeing the hand that occasioned it. What most harassed the Romans in the attack by sea, was a sort of crow with iron claws, fastened to a long chain, which was let down by a kind of lever. The weight of the iron made it fall with great violence, and drove it into the planks of the galleys. Then the besieged, by a great weight of lead at the other end of the lever, weighed it down, and consequently raised up the iron of the crow in proportion, and with it the prow of the galley to which it was fastened, sinking the poop at the same time into the water. After this the crow letting go its hold all of a sudden, the prow of the galley fell with such force into the sea, that the whole vessel was filled with water, and sunk. At other times, the machines, dragging ships to the shore by hooks, dashed them to pieces against the points of the rocks which projected under the walls. Other vessels were quite lifted up into the air, there whirled about with incredible rapidity, and then let fall into the sea, and sunk, with all that were in them. How these stupendous works were effected, few, if any, have hitherto been able to comprehend.

The troops under the command of Appius suffered no less in this second attack than the fleet. In the whole space of ground which the army, when formed, took up, the last files as well as the first were overwhelmed with showers of darts and flints, against which they could not possibly defend themselves. When they had with infinite trouble brought the mantlets and covered galleries, under which they were to work the rams, near the foot of the wall, Archimedes discharged such large beams and stones upon them as crushed them to pieces. If any brave Roman ventured to draw too near the wall, iron hooks were immediately let down from above, which, taking hold of his clothes or some part of his body, lifted him up in the air and dashed out his brains with the fall. Marcellus, though at a loss what to do, could not however forbear expressing himself with pleasantry: Shall we persist, said he to his workmen, in making war upon this Briareus, upon this giant with an hundred hands? But the soldiers were so terrified, that if they saw upon the walls only a small cord, or the least piece of wood, they immediately turned their backs and fled, crying out, that Archimedes was going to discharge some dreadful machine upon them.

The

Syracuse.

The consuls, finding themselves thus defeated in every attempt, turned the siege into a blockade, reduced most of the other places in the island, and defeated the forces which were sent against them; and at last Marcellus made himself master of Syracuse itself.

33 The siege turned into a blockade.

He took the opportunity of a festival, when the soldiers and citizens had drunk plentifully, to make a detachment scale the walls of Tyche, in that part of it which was nearest to Epipolæ, and which was ill guarded. He presently after possessed himself of Epipolæ; whereupon the inhabitants of Neapolis, as well as Tyche, sent deputies to him, and submitted.

34 Account of the taking of Syracuse.

35 The city plundered and Archimedes killed.

Marcellus granted life and liberty to all of free condition, but gave up those quarters of the city to be plundered. The soldiers had orders to spare the lives of the citizens; but they were cruel in their avarice, slew many of them, and among the rest the incomparable Archimedes. He was very intent on a demonstration in geometry, and calmly drawing his lines, when a soldier entered the room, and clapped a sword to his throat. "Hold! (said Archimedes) one moment, and my demonstration will be finished." But the soldier, equally regardless of his prayer and his demonstration, killed him instantly. There are different accounts of the manner of his death; but all agree that Marcellus regretted it extremely, and showed a singular favour to his relations for his sake.

36 Syracuse destroyed by the Saracens.

The city of Syracuse continued subject to the western empire till its declension, when the island of Sicily, being ravaged by different barbarians, the capital also underwent various revolutions; till at last, in the 9th century, it was so destroyed by the Saracens, that very few traces of its ancient grandeur are now to be seen. "The ancient city of Syracuse was of a triangular form, and consisted of five parts or towns. The circuit, according to Strabo, amounted to 180 stadia, or 22 English miles, and four furlongs. An account which Mr Swinburne once suspected of exaggeration; but, after spending two days in tracing the ruins, and making reasonable allowances for the encroachments of the sea, he was convinced of the exactness of Strabo's measurement.

At present it is fortified strongly toward the land, and the ditches of the bastions form the communications between the two havens. It is very weak towards the sea, but the shelves render it hazardous to debark on that side. The garrison is one of the best appointed in the kingdom, but the heights of Acradina command the works.

About eighteen thousand inhabitants are now contained in it. The dwellings are far from being memorials of ancient Syracusan architecture or opulence. In any other situation they might be thought tolerable; but to observers who reflect on the style of those buildings that probably once covered the same ground, the present edifices must have a mean appearance. The ancient temple of Minerva is now turned into a cathedral. The walls of the cella are thrown down, and only as much left in pillars as is necessary to support the roof; the intercolumniations of the peristyle are walled up. This temple is built in the old Doric proportions used in the rest of Sicily; its exterior dimensions are 185 feet in length and 75 in breadth. There are also some remains of Diana's temple, but now scarcely discernible. Besides these, there are few ruins in the island; and one is surprised that any should exist in a place which had been so often laid waste by enemies, and so often shaken by earthquakes. E. Long. 15. 27. N. Lat. 37. 3.

Syracuse, Syria.

SYRIA, a very ancient kingdom of Asia, lying between the Mediterranean on the west, the Euphrates on the east, and Arabia Deserta, Phœnicia, and Palestine, on the south.

1 Names, divisions, &c. of ancient Syria.

In ancient times this country was called *Aram*, probably from Aram the youngest son of Shem. At first it was parcelled out into several petty states; all of which seem afterwards to have been reduced under subjection to the four principal ones, Zobah, Damascus, Hamath, and Geshur. Afterwards the whole country was divided into two parts only, viz. Cœlesyria and Phœnicia; though the Phœnicians, Idumeans, Jews, Gazites, and Azotites, or the whole country of the Philistines, was included. After the death of Alexander, Syria in the great extent of the word, was divided, according to Strabo, into Comagene, Seleucis of Syria, Cœlesyria, Phœnice on the sea coast, and Judea in the midland. Ptolemy, however, subdivides these; and in the Proper Syria reckons only Comagene, Pieria, Cyrrhistica or Cyrrhestica, Seleucis, Cassiotis or Casiotis, Chalybonitis, Chalcidice or Chalcidene, Apamene, Laodicene, Phœnicia Mediterranea, Cœlesyria, and Palmyrene.

The history of the ancient Syrians, till the time of their being carried away by the kings of Assyria, is totally unknown, excepting a few particulars which may be gathered from Scripture, and which it is needless here to repeat. During the continuance of the Assyrian, Babylonian, and Persian monarchies, the history of this country affords nothing remarkable; but after the death of Alexander, it gave name to a very considerable empire, which makes a conspicuous figure in ancient history. At this time, however, it was not confined to Syria properly so called, but comprehended all those vast provinces of the Upper Asia which formed the Persian empire; being, in its full extent, bounded by the Mediterranean upon one side, and the river Indus on the other.

2 Seleucus the first king of Syria after Alexander the Great.

The first king was Seleucus, one of the generals of Alexander the Great; who, after the death of that conqueror, being made governor of Babylon, was tempted, by the example of Alexander's other captains, to set up for himself. Eumenes, who had sincerely at heart the interest of Alexander's family, solicited his assistance against Antigonus, who had openly revolted; but Seleucus not only refused his assistance, but attempted to destroy Eumenes himself with his whole army. Eumenes, however, found means to escape the danger without the loss of a man. On this Seleucus endeavoured to gain over his troops: but finding that impossible, he made a truce with Eumenes, and granted him a safe passage through his province; but at the same time sent an express to Antigonus, desiring him to fall upon him, before he was joined by the governors of Upper Asia. Antigonus did not fail to follow his advice; but having prevailed against Eumenes through treachery, he next thought of bringing Seleucus himself under subjection.

3 Obliged by Antigonus to fly into Egypt.

On his return to Babylon, therefore, after having been feasted with his whole army by Seleucus, he demanded of him an account of the revenues of his province. Receiving an unfavourable answer to this requisition, Antigonus was so much exasperated, that Seleucus, not thinking himself a match for him at that time, thought proper to fly into Egypt.

By

Syria.

By the flight of Seleucus, Antigonus was left master of all his provinces; but his son Demetrius being afterwards defeated by Ptolemy at Gaza, Seleucus began to think of recovering what he had lost. Having received from Ptolemy a very slender force, he set out towards Babylon, and procured reinforcements as he proceeded.

4 Becomes master of Babylon. An. 312. B. C.

As he approached the city, those who favoured Antigonus retired into the citadel, but were soon obliged to surrender; and in that fortress Seleucus found his children, friends, and domestics, whom Antigonus had kept prisoners ever since his flight into Egypt.

Seleucus having made himself master of Babylon, in the year 312 B. C. began to prepare for encountering Antigonus, who he knew would soon attack him with all his force.

5 Defeats Nicanor, and reduces Media and Susiana.

Nicanor, governor of Media under Antigonus, first advanced against him at the head of 10,000 foot and 7000 horse; but Seleucus, with only 3000 foot and 400 horse, having drawn him into an ambush, cut off almost the whole of his army, and such of the soldiers as had escaped the slaughter willingly enlisted under his banner.

The consequence of this victory was the submission of all Media and Susiana; but during his absence from the capital, Demetrius advanced towards it, and made himself master of it.

On the return of Seleucus to Babylon, he easily drove out the troops left by Demetrius, recovered the castle which he had garrisoned, and settled his authority on such a firm foundation, that it could never afterwards be moved. Having then marched again into Media, he defeated and killed with his own hand Nicanor or Nicator, whom Antigonus had sent against him; after which, having settled the affairs of Media, he reduced all Persia, Bactria, and Hyrcania, subjecting to his new empire these and all the other provinces on this side the Indus which had been conquered.

Seleucus being now master of all the countries which lie between the Euphrates and the Indus, took the title of king of Babylon and Media. But, not satisfied with these possessions, ample as they were, he crossed the Indus, in order to conquer those regions which had submitted to Alexander beyond that river. In this expedition, however, he was unsuccessful; but returning westward against his old enemy Antigonus, he defeated and killed him at Ipsus, and reduced his son Demetrius to a very dependent state. Seleucus now betook himself to the building of a city, which he called *Seleucia*, and which stood on the place where the city of Bagdad now stands. Besides these, he built a great many others; 16 of which he called *Antioch*, from the name of his brother Antiochus; nine *Seleucia*, from his own name; three *Apamea*, from Apama his first wife; one *Stratonicea*, from his second wife Stratonice; and six *Laodicea*, from his mother Laodice.

In 284 Seleucus entered into a war with Lysimachus, with whom he had hitherto lived in strict amity. Out of 36 general officers left by Alexander the Great, they two survived, and both were upwards of 70 years old. Nevertheless they were both filled with the ambition and animosity of young men.

6 Defeats and kills Lysimachus.

The two armies met at a place called *Curopedion* in Phrygia, where an obstinate engagement took place. Victory was long doubtful: but at last Lysimachus was run through with a spear, and died on the spot; on which his troops betook themselves to flight. This victory added to the possessions of Seleucus all those provinces which had formerly been subject to Lysimachus, and from this victory he is generally called *Nicator*, or *the conqueror*.

7 Is himself treacherously murdered.

His triumph, however, on this occasion, was but short-lived; for seven months after, as he was marching towards Macedon to take possession of that kingdom, he was treacherously murdered by Ptolemy Ceraunus, on whom he had conferred innumerable favours.

8 Antiochus Soter. An. 280. B. C.

Seleucus was succeeded by his son Antiochus Soter, who held the empire 19 years. He resigned to Antigonus Gonatus all pretensions to the crown of Macedon; and having engaged in a war with Eumenes king of Pergamus, he was defeated by him, and obliged to yield up part of his dominions.

9 Antiochus Theos. An. 261 B. C.

He died in 261 B. C. and was succeeded by his son Antiochus Theos; who having engaged in a war with Ptolemy Philadelphus king of Egypt, the Parthians and Bactrians took that opportunity to revolt, and could never afterwards be reduced. In 246 B. C. he was poisoned by his wife Laodice, who raised to the throne her own son, named *Seleucus Callinicus*.

10 Seleucus Callinicus. An. 246. B. C.

He was succeeded by his eldest son Seleucus Ceraunus, a weak prince, who was poisoned by a conspiracy of two of his officers, when he had reigned one year; after which his brother Antiochus, surnamed the *Great*, ascended the throne in 225 B. C.

11 Antiochus the Great. An. 225. B. C.

In the very beginning of his reign, two of his generals, Alexander and Molo, rebelled against him. The former had been appointed governor of Persia, and the latter of Media. Antiochus marched against the rebels, whom he defeated in a pitched battle; on which their chiefs laid violent hands on themselves.

12 Suppresses one rebellion, but is embarrassed by another.

On his return he received the submission of the Atropatii, a barbarous people in Media; and put to death his prime minister Hermias, whom he had found hatching treacherous designs against him. During his lifetime, however, the traitor, by accusing Achæus of treason, had obliged him to revolt in his own defence; so that the king had still two important wars on his hands, viz. one with Ptolemy king of Egypt, and the other against Achæus. After some deliberation, he resolved to march first against the king of Egypt; and was at first very successful, reducing many cities in Cœlesyria and Palestine, and defeating the Egyptians in a pitched battle; but in the year 217 B. C. being worsted in the battle of Raphia, he was obliged to abandon all his conquests; of which Ptolemy immediately took possession, and Antiochus was obliged to cede them to him, that he might be at leisure to pursue the war against Achæus.

Antiochus having made vast preparations for his expedition, soon reduced Achæus to such distress, that he was obliged to shut himself up in the city of Sardis, which he defended for some time with great bravery; till at last, being betrayed by two Cretans, he was delivered up to the king, and by his order put to death.

13 His successes in the east.

Antiochus then undertook an expedition against the Parthians, whom he obliged to conclude a peace on very advantageous terms. He then turned his arms against the king of Bactria, whom he also compelled to agree to his terms. He then crossed Mount Caucasus, and entered India; where he renewed his alliance with the king of that country. From India he marched into Arachosia, Drangiana, and Carmania, establishing order and discipline in all those countries: then passing through Persia, Babylonia, and Mesopotamia, he returned to Antioch, after an absence of seven years.

In

Syria.

14 Enters into a league with Philip of Macedon against the king of Egypt. An. 204. B. C.

In the year 204 B. C. Antiochus entered into a league with Philip of Macedon, on purpose to deprive Ptolemy Epiphanes, the infant king of Egypt, of all his dominions. He defeated the Egyptian general, recovered all Palestine and Cœlesyria; after which he invaded Asia Minor, in hopes of reducing it also, and restoring the Syrian empire to the same extent it had in the time of Seleucus Nicator. The free cities in Asia Minor immediately had recourse to the Romans, who sent an embassy to Antiochus on the occasion;

15 His conquests checked by the Romans.

but as both parties put on those haughty and imperious airs to which they thought the greatness of their power gave them a right, no satisfaction was given, but every thing tended to an open rupture. While matters were in this situation, Hannibal the Great, being obliged to leave

16 Hannibal flees to him for protection.

his own country, fled to Antiochus: from whom he met with a gracious reception. As Hannibal had, while a child, sworn perpetual enmity against the Romans, he used all his eloquence to persuade Antiochus to make war with them; and as the many victories which he had gained over them left no room to doubt of his capacity, Antiochus doubted nothing of being able, by his assistance, to conquer that haughty people. Several embassies passed between the two nations; but chiefly with a design, on the part of Antiochus, to gain time. Hannibal endeavoured to draw his countrymen into the confederacy against Rome, but without effect.

17 Antiochus neglects the advice of Hannibal

Antiochus having strengthened himself by several alliances, at last resolved to begin the war in earnest. The king imprudently became the aggressor, by falling on a body of 500 Romans before war had been declared. He also made King Philip his enemy, by entertaining the

18 His shameful behaviour.

regent of Athamania, who was a pretender to the crown of Macedon. To complete all, he himself fell in love, though above 50 years of age, with a beautiful young woman of Chalcis, whom he married; and became so great a slave to this passion, that he entirely neglected his affairs; the army gave themselves up entirely to dissipation and debauchery, and every trace of military discipline vanished.

19 Is defeated by the Romans at Thermopylæ. An. 191. B. C.

In the year 191 B. C. Antiochus was roused from his lethargy by a declaration of war against him at Rome, and set out for Ætolia. His army at this time amounted to no more than 10,000 foot and 500 horse. He had been made to believe that he would receive a vast reinforcement in Ætolia: but when he came to make the experiment, he soon found his mistake; all the troops he could raise there amounted to no more than 4000 men. With this force, so exceedingly inadequate to the purpose, he was obliged to oppose the Roman army, who were advancing in conjunction with the Macedonians, and had already made surprising progress. Antiochus seized the straits of Thermopylæ; but was driven from them by the Romans, the king himself being the first that fled. Almost his whole army was destroyed in the battle or in the pursuit, and Antiochus returned with disgrace into Asia.

Soon after his return, Antiochus equipped a fleet of 200 sail; on which he immediately embarked for the Thracian Chersonesus, now Crim Tartary. He fortified the cities of Lysimachia, Sestus, and Abydos, with others in that neighbourhood, to prevent the Romans from crossing the Hellespont. In the mean time Polyxenidas the Syrian admiral sent intelligence to the king that the Roman fleet had appeared off Delos; upon which he desired him to seek them out and engage them at all events. He did so, and was defeated with the loss of 40 ships taken or sunk in the engagement.

20 His fleet defeated by that of the Romans.

This was soon after revenged by the destruction of the Rhodian fleet by the artifice of Polyxenidas; but in the end the king's affairs went everywhere to wreck. Having laid siege to the city of Pergamus, he was obliged to raise it with loss; the Phœnician fleet commanded by

21 Meets with two other defeats, and becomes like one infatuated.

Hannibal was defeated by the Rhodians: and soon after the Syrian fleet under Polyxenidas was utterly defeated by the Romans. Antiochus was so much disheartened by these repeated defeats, that he appeared like one infatuated. Instead of fortifying more strongly those cities which lay on the frontiers of his kingdom, he entirely deserted them: and thus Lysimachia and Abydos, the two keys to Asia, fell into the hands of the Romans without the least resistance.

The arrival of the Romans in Asia struck Antiochus with such terror, that he instantly sued for peace. The terms he offered were indeed very advantageous, but by no means agreeable to the expectations of the Romans.

22 Sues for peace, but is refused.

They therefore gave him his final answer: 1. That since he had drawn upon himself the war, he should defray the whole expence of it; 2. That he should restore liberty in general to all the Greek cities in Asia; and, 3. That to prevent future hostilities, he should relinquish all Asia on this side Mount Taurus. These terms, however, still appeared to him so intolerable, that he resolved to continue the war; and determined also to take the most imprudent method of carrying it on, namely, by hazarding all on the event of a general engagement. The king encamped near Magnesia, and strongly fortified his camp. The Romans insulted him in his trenches, and proposed to attack his fortifications if he continued to decline an engagement. At last the king, thinking it would be shameful for him longer to refuse an engagement, being at the head of an army far more numerous than that of the enemy, in a friend's country, and in the midst of his allies, resolved at all events to accept the challenge, and accordingly prepared for a decisive battle.

23 Battle of Magnesia.

On the day of the battle the weather proved very favourable to the Romans; for a thick fog rising in the morning, the day was almost turned into night, so that the Syrian commanders could not have all the corps under their command in view, on account of their great extent, nor send them proper orders in time; whereas the fog was not thick enough to prevent the Roman generals from seeing their several bodies at the greatest distance, as they took up but little ground. Besides, the damp which was occasioned by the fog slackened the strings of the enemy's bows, so that the Asiatics who used them could shoot their darts and arrows but faintly. The whole dependence of Antiochus in the first attack was on his armed chariots, which were to cut their way into the Roman army. But Eumenes, king of Pergamus, undertook to render them useless, and even fatal, to the enemy. After this advantage, the Roman cavalry advanced, and fell on those whom the chariots

24 The Syrians defeated.

had put in disorder. The Syrians being already intimidated, after a faint resistance gave way; and the Romans made a great slaughter of their men and horses, both being borne down with the weight of their heavy armour. Eumenes charged the left wing, in which Seleucus commanded, with such vigour, that he put it to flight;

Syria. and the fugitives flying to the phalanx for protection, put that body likewise in disorder; which Domitius observing, advanced against it at the head of his legionaries, but could not break it till he ordered his men to attack the elephants which the Syrians had placed in the spaces between the companies. The Romans had learned, in their wars with Pyrrhus and Hannibal, not to fear those monsters which were once so terrible to them. They attacked them, therefore, with great resolution; and driving them against the phalanx, put that body into disorder, by means of those very animals which had been posted there for its defence.

After a long and bloody contest, the Syrians were totally routed, and the Romans walking over heaps of
25 And their camp taken. dead bodies, marched up to the Syrian camp, attacked, and plundered it. The riches they found in it are not to be described; but the taking of it cost the Romans a new battle, which proved more fatal to the Syrians than that in the field; for the Romans having, in spite of a most desperate resistance, forced the intrenchments, gave no quarter, but put all to the sword without distinction. There fell this day in the battle, in the pursuit, and in the plunder of the camp, 50,000 foot and 4000 horse; 1500 were taken prisoners, and 15 elephants. In the consular army there were but 300 foot killed and 35 horse. Eumenes had only 15 of his men killed; so that this victory, as we are told by the ancients, seemed a prodigy to all nations both of the east and west.

Antiochus retired to Sardis with as many of his forces that had escaped the slaughter as he could draw together. From Sardis he soon marched to rejoin his son Seleucus, who had fled to Apamea. As for the consul, he took advantage of the king's defeat and flight, making himself master of all the neighbouring countries. Deputies hastened to him from all parts; the cities of Thyatira, Magnesia, Trallis, Magnesia in Caria, all Lydia, and Ephesus itself, though highly favoured by Antiochus, declared for the Romans. Polyxenidas, upon the news of the king's defeat, left the port of Ephesus, and sailed to Patara, where he landed with a very small guard, and returned by land into Syria. The consul took the road to Sardis, which opened its gates to him.

Antiochus finding his affairs in a bad situation both by sea and land, and not daring to appear before the consular army in the field, sent Antipater his brother's son, and Zeuxis, who had been governor of Lydia and Phrygia, to sue for a peace. They were ordered to treat chiefly with the elder Scipio, of whose clemency and good nature Antiochus entertained a high opinion. Accordingly, on their arrival at Sardis, where the consul then was with his brother, they addressed the latter, and were by him presented to the consul. Their speech was very submissive, and such as became a vanquished people.

26 Antiochus obtains peace on very hard terms. Hereupon a council was summoned, and after long debates the ambassadors were called in; and Scipio Africanus proposed terms that were very humiliating.

The ambassadors of Antiochus had been ordered to refuse no terms; and therefore these were accepted and the whole affair concluded. So that the Syrian ambassadors now prepared to set out for Rome, to get the conditions of peace proposed by Scipio ratified there. L. Aurelius Cotta was sent with the ambassadors to Rome, to acquaint the senate with the particulars of the treaty. When they appeared before the conscript fathers, they spoke with great submission, and only desired them to ratify the articles which the Scipios had offered to their master. The senate, after examining them, ordered that a treaty of peace should be concluded with Antiochus, and the articles of it engraved on brass, and fixed up in the Capitol. They only added one clause, which was, That the Syrians should change every year all their hostages, except the son of King Antiochus, who should continue at Rome as long as the republic thought fit. The peace being thus ratified, and all Asia on this side Mount Taurus delivered into the hands of the Romans, the Greek cities were by them restored to their liberty, the provinces of Caria and Lydia given to the Rhodians, and all the rest that had belonged to Antiochus bestowed upon Eumenes.

Antiochus did not long survive his misfortune at Magnesia. He died in 187, and with him fell the glory of the Syrian empire. 27 His death. An. 187. B.C. The Romans now gave laws to the kings of Syria, insomuch, that when Antiochus Epiphanes the grandson of Antiochus the Great hesitated at obeying the command of the senate, one of the ambassadors drew a circle round him with a rod on the floor, and told him that he should not go out of that spot before he had told him what he was to do. The most remarkable transactions of this prince are his wars with the Jews, and persecutions of them; of which a full account is given under the article JEWS. After a variety of usurpers and tyrants, the kingdom of Syria fell under Tigranes king of Armenia in the year 83 B. C.; and upon his overthrow by the Romans, it became a province of the dominions of the republic. 28 Syria becomes a Roman province From them it was taken by the Saracens in the reign of the caliph Omar, and is now a province of Turkey in Asia. See ACRE.

Syria is in some measure only a chain of mountains, varying in their levels, situation, and appearances. 29 Climate, soil, &c. of the country. The part of the country, however, next the sea is in general low, and besides this there are several extensive valleys. The climate on the sea-coast and in these valleys is very hot, but in the higher parts of the country it bears a good deal of resemblance to that of France. Syria is exceedingly fertile, and the variety of its productions is very great. Besides wheat, rye, barley, beans, and the cotton plant, which is cultivated everywhere, Palestine abounds in sesamum, from which oil is procured, and doura as good as that of Egypt. Maize thrives in the light soil of Balbec, and even rice is cultivated with success on the borders of the marshy country of Havula. They have lately begun to plant sugarcanes in the gardens of Saide and of Bairout, and they find them equal to those of the Delta. Indigo grows without cultivating on the banks of the Jordan, in the country of Bisan, and only requires care to make it of an excellent quality. The hill-sides of Latakia produce tobacco. Gaza produces dates like Mecca, and pomegranates like Algiers; Tripoli affords oranges equal to those of Malta; Bairout figs like those of Marseilles, and bananas not inferior to those of St Domingo; Aleppo enjoys the exclusive advantage of producing pistachios; and Damascus justly boasts of possessing all the fruits known in France. Its stony soil suits equally the apples of Normandy, the plums of Touraine, and the peaches of Paris. Volney's Travels, vol. i.

Paris. Twenty sorts of apricots are reckoned there, the stone of one of which contains a kernel highly valued through all Turkey. The cochineal plant, which grows on all that coast, contains perhaps that precious insect in as high perfection as it is found in Mexico and St Domingo.

The inhabitants may be divided into three principal classes: the descendants of the Greeks of the Lower Empire; the Arabs, their conquerors; and the Turks, the present ruling power: and these again, the first into three, the second into four, classes; besides three wandering tribes of Turkomans, Curds, and Bedouin Arabs. The ancient inhabitants before the Greeks under Alexander are entirely lost. The inhabitants are in general of a middling stature, and the eyes of the women almost everywhere beautiful, and their shape correct and well proportioned. The general language is Arabic.

SYRINGA, the LILAC, a genus of plants belonging to the class diandria, and in the natural system ranging under the 44th order, *Sepiariæ*. See BOTANY *Index*.

SYRINGE, a well-known instrument, serving to imbibe or suck in a quantity of fluid, and to squirt or expel the same with violence. The word is formed from the Greek συριγξ, or the Latin *syrinx*, "a pipe." —A syringe is only a single pump, and the water ascends in it on the same principle as in the common sucking-pump. See HYDRODYNAMICS.

SYRUP, in *Pharmacy*, a saturated solution of sugar, made in vegetable decoctions or infusions. See MATERIA MEDICA.

SYSTEM, in general, denotes an assemblage or chain of principles and conclusions, or the whole of any doctrine, the several parts whereof are bound together, and follow or depend on each other; in which sense we say a *system of philosophy*, *system of divinity*, &c. The word is formed from the Greek συστημα, "composition, compages."

SYSTEM, in the animal economy, the *vascular*, the *nervous*, and the *cellular*. See ANATOMY.

SYSTEM, in *Music*, an assemblage of the rules for harmony, deduced from some common principle by which they are reunited; by which their connection one with another is formed; from whence, as from their genuine source, they natively flow; and to which, if we would account for them, we must have recourse. See the articles CHROMATIC, DIATONIC, ENHARMONIC, HARMONY, INTERVAL, and MUSIC.

SYSTEM, in *Botany*. See BOTANY.

SYSTEM, in *Astronomy*. See ASTRONOMY.

SYSTOLE, in *Anatomy*, the contraction of the heart, whereby the blood is drawn off its ventricles into the arteries; the opposite state to which is called the *diastole*, or *dilatation of the heart*. See ANATOMY *Index*.

SYSTYLE, in *Architecture*, that manner of placing columns where the space between the two shafts consists of two diameters or four modules.

SYZYGY, SYZYGIA, in *Astronomy*, a term equally used for the conjunction and opposition of a planet with the sun. The word is formed from the Greek συζυγια, which properly signifies *conjunctio*. On the phenomena and circumstances of the syzygies a great part of the lunar theory depends. See ASTRONOMY.

T.

T, or t, the 19th letter and 16th consonant of our alphabet; the sound whereof is formed by a strong expulsion of the breath through the mouth, upon a sudden drawing back of the tongue from the fore-part of the palate, with the lips at the same time open. The proper sound of *t* is expressed in most words beginning or ending with that letter; as in *take*, *tell*, *hot*, *put*. *Ti* before a vowel has the sound of *si*, or rather of *shi*, as in *creation*, except when *s* precedes, as in *question*; and in derivatives from words ending in *ty*, as *mighty*, *mightier*. *Th* has two sounds; the one soft, as *thou*, *father*; the other hard, as *thing*, *think*. The sound is soft in these words, *then*, *thence*, and *there*, with their derivatives and compounds; and in the words *that*, *this*, *thus*, *thy*, *they*, *though*; and in all words in which *th* comes between two vowels, as, *whether*, *rather*; and between *r* and a vowel, as *burthen*.

In abbreviations, amongst the Roman writers, T. stands for *Titus*, *Titius*, &c.; Tab. for *Tabularius*; Tab. P. H. C. *Tabularius Provinciæ Hispaniæ Citerioris*; Tar. *Tarquinius*; Ti. *Tiberius*: Ti. F. *Tiberii filius*; Ti. L. *Tiberii libertus*: Ti. N. *Tiberii Nepos*; T. J. A. V. P. V. D. *tempore judicem arbitrumve postulat ut det*; T. M. P. *terminum posuit*; T. M. D. D. *terminum dedicavit*; Tr. *trans*, *tribunus*; Tr. M. or Mil. *tribunus militum*; TR. PL. DES. *tribunus plebis designatus*; TR. AER. *tribunus ærarii*; TRV. CAP. *triumviri capitales*; T. P. or TRIB. POT. *tribunicia potestate*; Tul. H. *Tullus Hostilius*.

Amongst the ancients, T, as a numeral, stood for *one hundred and sixty*; and with a dash at top, thus $\bar{T}$, it signified *one hundred and sixty thousand*. In music, T stands for *tutti*, "all, or altogether."

TABANUS, the BREEZE-FLY; a genus of insects belonging to the order of diptera. See ENTOMOLOGY *Index*.

TABARCA, a small island lying opposite to a town of the same name, which divides the maritime coasts of Tunis and Algiers, in Africa. It is two miles from the land, and is in possession of the noble family of the Lamellini of Genoa, who have here a governor and a garrison of 200 men to protect the coral fishery. N. Lat. 36. 50. E. Long. 9. 16.

TABASHEER, a Persian word, signifying a hard substance found in the cavities of the bamboo or Indian reed, and highly valued as a medicine in the East Indies.

Though some account was given of the tabasheer by the Arabian physicians, no accurate knowledge of it was obtained till Dr Russel favoured the public with his observations on it.

The tabasheer is produced from the female bamboo, which is distinguished from the male by a larger cavity. The bamboos containing it make a rattling noise when shaken. Dr Russel having examined a bamboo brought from Vellore, consisting of six joints, found no tabasheer in two of them: all the rest contained some, but of various quality and quantity; the whole amounting to about 27 grains. The best was of a bluish white, resembling small fragments of shells, harder also than the rest, but which might be easily crumbled between the fingers into a gritty powder; and when applied to the tongue and palate, had a slight saline and testaceous taste; the weight not exceeding four grains. The colour of the rest was cinerititous, rough on the surface, and more friable; having some particles of a larger size intermixed, but light, spongy, and somewhat resembling pumice stones; which appearance, our author supposes, led the Arabians to think that fire was concerned in the production. The two middle joints were of a pure white colour within, and lined with a thin film. In these the tabasheer was principally found. The other joints, particularly the two upper ones, were discoloured within; and in some parts of the cavity was found a blackish substance in grains or in powder, adhering to the sides, the film being there obliterated. In two or three of the joints a small round hole was found at top and bottom, which seemed to have been perforated by some insect.

Garzius informs us, that it is not found in all bamboos, or in all the branches indiscriminately, but only in those growing about Bisnagur, Batecala, and one part of the Malabar coast. Dr Russel was informed by a letter from a medical gentleman attending the embassy to the Nizam, that though tabasheer bears a high price at Hydrabad, it is never brought thither from Bisnagur; and that some of what is sold in the markets comes from the pass of Atcour in Canoul; and some from Emnabad, at the distance of about 80 miles to the north-west; but that the most part comes from Masulipatam. That sold in the markets is of two kinds; one the rate of a rupee per dram, but the other only half that price; the latter, however, is supposed to be factitious, and made up mostly of burnt teeth and bones. Dr Russel himself also, is persuaded that the tabasheer met with in commerce is greatly adulterated. The above-mentioned gentleman likewise informed the doctor that tabasheer was produced in great quantities at Sylhat, where it is sold by the pound, from one rupee to one and a half; forming a considerable article of trade from Bengal to Persia and Arabia. There is, however, a third kind, much superior in quality, being whiter, purer, and also harder and heavier.

Dr Russel supposes that the tabasheer is the juice of the bamboo thickened and hardened. The following observations on its medical effects were taken from a Persian work, intitled the "Tofut ul Monein of Mahommed Monein Hoseiny," by Mr Williams a surgeon in the service of the East India company. The tabasheer puts a stop to bilious vomitings and to the bloody flux. It is also of service in cases of palpitation of the heart [illegible] and for strengthening those members of the body that are weakened by heat. It is useful also for the piles, and for acute or burning fevers, and for pustules in the mouth (thrush); and, given with oxymel, is of service against restlessness, melancholy, and hypochondriacal affections. The habitual internal use of it is prejudicial to the virile powers. It is also said to be prejudicial to the lungs. Its correctives are the gum of the pine and honey. The dose of it is to the weight of two d'herems, or seven mashás.

TABBY, in *Commerce*, a kind of rich silk which has undergone the operation of tabbying.

TABBYING, the passing a silk or stuff under a callender, the rolls of which are made of iron or copper variously engraven, which bearing unequally on the stuff renders the surface thereof unequal, so as to reflect the rays of light differently, making the representation of waves thereon.

TABELLIO, in the Roman law, an officer or scrivener, much the same with our notaries public, who are often called *tabelliones*.

TABERNACLE, among the Hebrews, a kind of building, in the form of a tent, set up, by express command of God, for the performance of religious worship, sacrifices, &c. during the journeying of the Israelites in the wilderness: and, after their settlement in the land of Canaan, made use of for the same purpose till the building of the temple of Jerusalem. It was divided into two parts; the one covered, and properly called the *tabernacle;* and the other open, called the *court*. The curtains which covered the tabernacle were made of linen, of several colours, embroidered. There were ten curtains, 28 cubits long and four in breadth. Five curtains fastened together made up two coverings, which covered up all the tabernacle. Over these there were two other coverings; the one of goat's hair, the other of sheep's skins. The holy of holies was parted from the rest of the tabernacle by a curtain made fast to four pillars, standing ten cubits from the end. The length of the whole tabernacle was 32 cubits, that is, about 50 feet; and the breadth 12 cubits or 19 feet. The court was a spot of ground 100 cubits long, and 50 in breadth, enclosed by 20 columns, each 20 cubits high and 10 in breadth, covered with silver, and standing on copper bases, five cubits distant from one another; between which there were curtains drawn, and fastened with hooks. At the east end was an entrance, 20 cubits wide, covered with a curtain hanging loose.

Feast of TABERNACLES, a solemn festival of the Hebrews, observed after harvest, on the 15th day of the month Tisri, instituted to commemorate the goodness of God, who protected the Israelites in the wilderness, and made them dwell in booths, when they came out of Egypt. On the first day of the feast they began to erect booths of the boughs of trees, and in these they were obliged to continue seven days. The boughs were placed in the open air, and were not to be covered with cloths, nor made too close by the thickness of the boughs; but so loose that the sun and the stars might be seen, and the rains descend through them. For further particulars of the celebration of this festival, see Levit. ch. xxiii.

TABERNÆ, in *Ancient Geography*. See *TRES Tabernæ*.

TABERNÆMONTANA, in *Botany*, a genus of plants belonging to the class of pentandria, and order of monogynia; and in the natural system arranged under the

the 30th order, *Contortæ*. There are two horizontal follicles, and the seeds are immersed in pulp. There are eight species, all of foreign growth.

TABLE, a moveable piece of furniture, usually made of wood or stone, and supported on pillars or the like, for the commodious reception of things placed thereon.

TABLE is also used for the fare or entertainment served up.

TABLE, in *Mathematics*, systems of numbers calculated to be ready at hand for the expediting astronomical, geometrical, and other operations.

TABLE-Book. See WRITING.

TABLE-Mountain, a mountain of Africa, being the most westerly cape or promontory in that part of the world, and near the Cape of Good Hope. The bay which is formed thereby is called the *Table-bay*.

Laws of the Twelve TABLES, were the first set of laws of the Romans: thus called either because the Romans then wrote with a style on thin wooden tablets covered with wax; or rather, because they were engraved on tables or plates of copper, to be exposed in the most noted part of the public forum. After the expulsion of the kings, as the Romans were then without any fixed or certain system of law, at least had none ample enough to take in the various cases that might fall between particular persons, it was resolved to adopt the best and wisest laws of the Greeks. One Hermodorus was first appointed to translate them, and the decemviri afterwards compiled and reduced them into ten tables. After a world of care and application, they were at length enacted and confirmed by the senate and an assembly of the people, in the year of Rome 303. The following year they found something wanting therein, which they supplied from the laws of the former kings of Rome, and from certain customs which long use had authorised: all these being engraven on two other tables, made the law of the twelve tables, so famous in the Roman jurisprudence, the source and foundation of the civil or Roman law.

TABLES of the Law, in Jewish antiquity, two tables on which were written the decalogue, or ten commandments, given by GOD to Moses on Mount Sinai.

TABOO, a word used by the South sea islanders, nearly of the same import as prohibited or interdicted. It applies equally to persons and things, and is also expressive of any thing sacred, devoted, or eminent.

TABOR, a mountain of Galilee, about 12 miles from the city of Tiberias. It rises in the form of a sugar loaf, in the midst of an extensive plain, to the height of 30 stadia, according to Josephus. The ascent is so easy, that one may ascend on horseback. On the top there is a plain two miles in circumference.

The situation of Mount Tabor is most delightful. Rising amidst the plains of Galilee, it exhibits to the enchanted eye a charming variety of prospects. On one side there are lakes, rivers, and a part of the Mediterranean; and on the other a chain of little hills, with small valleys, shaded by natural groves, and enriched by the hands of the husbandman with a great number of useful productions. Here you behold an immensity of plains interspered with hamlets, fortresses, and heaps of ruins; and there the eye delights to wander over the fields of Jezrael or Mageddon, named by the Arabs *Ebn-Aamer*, which signifies "the field of the sons of Aamer." A little farther you distinguish the mountains of Hermon, Gilboa, Samaria, and Arabia the Stony. In short, you experience all those sensations which are produced by a mixture and rapid succession of rural, gay, gloomy, and majestic objects.

Mariti's Travels, vol. ii.

It was upon this enchanting mount that the apostle Peter said to Christ, "It is good for us to be here: and let us make three tabernacles; one for thee, and one for Moses, and one for Elias."

Flavian Josephus, governor of Galilee, caused the summit of this mountain, for the space of two miles and a half, to be surrounded with walls. The inhabitants of Tabor long braved the power of the Roman armies; but being deprived of water in consequence of the great heats, they were forced to surrender at discretion to Placidus, the general of Vespasian.

Several churches were built upon this mountain by St Helen, who founded here also some monasteries. Of the two most remarkable, one was dedicated to Moses, and inhabited by Cenobites of the order of St Benedict, who followed the Latin rites: the other was dedicated to the prophet Elias by monks of the order of St Basil, attached to the Greek rites. The kings of Hungary erected here also a pretty spacious convent for some monks belonging to that nation, of the order of St Paul the first hermit. Tabor was also the seat of a bishop, dependant on the patriarchate of Jerusalem.

When Godfrey of Bouillon seized on this mountain, he repaired the ancient churches, which were beginning to fall into ruins. Under Baldwin I. in 1113, the Saracen troops retook Tabor; and their sanguinary fury gained as many victories as there were priests and Cenobites. This mountain again fell into the hands of the Christians; but the Catholic standard was not long displayed on it. Saladin pulled it down the year following, and destroyed all the churches. The Christians retook it once more in 1253; and their zeal made them rebuild all the sacred places. At this time Rome being accustomed to give away empires, Pope Alexander IV. granted Tabor to the Templars, who fortified it again. At length, in the course of the year 1290, the sultan of Egypt destroyed and laid waste the buildings of this mountain, which could never be repaired afterwards; so that at present it is uninhabited.

TACAMAHACA, in *Pharmacy*, a gum resin, obtained from the fagara octandra and populus balsamifera; and having a fragrant smell, a bitterish nauseous taste, and supposed to be stimulant and tonic in its effects.

TACCA, a genus of plants belonging to the class dodecandria. See BOTANY *Index*.

TACHYGRAPHY, from ταχυς, *short*, and γραφω, *I write*, or the art of writing short-hand. See STENOGRAPHY.

TACITUS, CAIUS CORNELIUS, a celebrated Roman historian, and one of the greatest men of his time, appears to have been born about the year of Rome 809 or 810, and applied himself early to the labours of the bar, in which he gained very considerable reputation. Having married the daughter of Agricola, the road to public honours was laid open to him in the reign of Vespasian; but during the sanguinary and capricious tyranny of Domitian, he, as well as his friend Pliny, appears to have retired from the theatre of public affairs. The reign of Nerva restored these luminaries of Roman literature to the metropolis, and we find Tacitus engaged, in A. U. C. 850, to pronounce the funeral oration

Murphy's Translation of Tacitus.

Tacitus. oration of the venerable Virginius Rufus, the colleague of the emperor in the consulship, and afterwards succeeding him as consul for the remainder of the year.

The time of his death is not mentioned by any ancient author, but it is probable that he died in the reign of Trajan.

His works which still remain are, 1. Five books of his History. 2. His Annals. 3. A Treatise on the different Nations which in his time inhabited Germany: and, 4. The Life of Agricola his father-in-law. There is also attributed to him a Treatise on Eloquence, which others have ascribed to Quintilian. The Treatise on the Manners of the Germans was published in 851.—In the year 853, Pliny and Tacitus were appointed by the senate to plead the cause of the oppressed Africans against Marius Priscus, a corrupt proconsul, who was convicted before the fathers; and the patriot orators were honoured with a declaration that they had executed their trust to the entire satisfaction of the house. The exact time when Tacitus published his history is uncertain, but it was in some period of Trajan's reign, who died suddenly, A. U. C. 870, A. D. 117.—The history comprises a period of 27 years, from the accession of Galba, 822, to the death of Domitian, 849. The history being finished, he did not think he had completed the tablature of slavery; he went back to the time of Tiberius: and the second work, which, however, comes first in the order of chronology, includes a period of 54 years, from the accession of Tiberius, 767, to the death of Nero, 821: this work is his "Annals."

Biographical Dictionary. It is remarkable, that princes and politicians have always held the works of Tacitus in the highest esteem; which looks as if they either found their account in reading them, or were pleased to find courts, and the people who live in them, so exactly described after the life as they are in his writings. Part of what is extant was found in Germany by a receiver of Pope Leo X. and published by Beroaldus at Rome in 1515. Leo was so much charmed with Tacitus, that he gave the receiver a reward of 500 crowns; and promised not only indulgences, but money also and honour, to any one who should find the other part; which it is said was afterwards brought to him. Pope Paul III. as Muretus relates, wore out his Tacitus by much reading it; and Cosmo de Medicis, who was the first great duke of Tuscany, and formed for governing, accounted the reading of him his greatest pleasure. Muretus adds, that several princes, and privy-counsellors to princes, read him with great application, and regarded him as a sort of oracle in politics. A certain author relates, that Queen Christina of Sweden, though extremely fond of the Greek tongue, which she made "the diversion of her leisure hours, was not restrained by that from her serious studies; so she called among others Tacitus's History, some pages of which she read constantly every day." Lastly, Lord Bolingbroke, an authority surely of no mean rank, calls him, "a favourite author," and gives him manifestly the preference to all the Greek and Roman historians.

Baillet Vie de Des Cartes, tom. ii. Study of History, Letter v.

No author has obtained a more splendid reputation than Tacitus. He has been accounted, and with good reason, the most cultivated genius of antiquity; and we must not seek for his parallel in modern times. It is impossible not to admire and recommend his intimate knowledge of the human heart, the spirit of liberty which he breathes, and the force and vivacity with which he perpetually expresses himself. The reader of taste is struck by the greatness of his thoughts and the dignity of his narration; the philosopher by the comprehensive powers of his mind; and the politician by the sagacity with which he unfolds the springs of the most secret transactions. Civil liberty and the rights of mankind never met with a bolder or a more able assertor: servitude, debasement, and tyranny, appear not in the writings of any other author in juster or more odious colours. He has been censured as obscure; and indeed nothing can be more certain than that he did not write for the common mass of men. But to those who are judges of his compositions, it is no matter of regret that his manner is his own, and peculiar. Never were description and sentiment so wonderfully and so beautifully blended; and never were the actions and characters of men delineated with so much strength and precision. He has all the merits of other historians, without their defects. He possesses the distinctness of Xenophon without his uniformity; he is more eloquent thon Livy, and is free from his superstition; and he has more knowledge and judgment than Polybius, without his affectation of reasoning on every occasion.

Tacitus, Tack.

One of the best editions of the works of Tacitus was published at Paris by Brotier, in 4 vols. 4to. There have been four translations of his works into English; the first by Greenway and Sir Henry Saville, in the reign of Elizabeth; the second by Dryden and others; the third by Gordon, which is remarkable for affectation of style, though some think it bears a striking resemblance to the original; and the fourth and best by Murphy, in 1793, in 4 vols. 4to.

TACK, a rope used to confine the foremost lower corners of the courses and stay-sails in a fixed position, when the wind crosses the ship's course obliquely. The same name is also given to the rope employed to pull out the lower corner of a studding-sail or driver to the extremity of its boom.

The main-sail and fore-sail of a ship are furnished with a tack on each side, which is formed of a thick rope tapering to the end, and having a knot wrought upon the largest end, by which it is firmly retained in the clue of the sail. By this means one tack is always fastened to windward, at the same time that the sheet extends the sail to the leeward.

TACK, is also applied, by analogy, to that part of any sail to which the tack is usually fastened.

A ship is said to be on the starboard or larboard tack, when she is close-hauled, with the wind upon the starboard or larboard side; and in this sense the distance which she sails in that position is considered as the length of the tack; although this is more frequently called *board*. See that article.

To TACK, to change the course from one board to another, or turn the ship about from the starboard to the larboard tack, in a contrary wind. Thus a ship being close-hauled on the larboard tack, and turning her prow suddenly to windward, receives the impression of the wind on her head sails, by which she falls off upon the line of the starboard tack. Tacking is also used in a more enlarged sense, to imply that manœuvre in navigation by which a ship makes an oblique progression to the windward, in a zig-zag direction. This, however, is more usually called *beating*, or *turning to windward*.

Falconer's Marine Dictionary.

ward. See NAVIGATION, SAILING, and *Naval Tactics*, under WAR.

TACK, in *Scots Law.* See LAW, N° clxvii.

TACKLE, among seamen, denotes all the ropes or cordage of a ship used in managing the sails, &c.

TACKSMAN. See TENURE.

TACTICS, in the art of war, is the method of disposing forces to the best advantage in order of battle, and of performing the several military motions and evolutions. See WAR.

TADCASTER, a town in the west riding of Yorkshire, noted for the great plenty of limestone dug up near it; and for being one of the first places in which a building was erected for Sunday schools. It is nine miles from York, and 188 from London.

TADMOR. See PALMYRA.

TADPOLE, a young frog before it has disengaged itself from the membranes that envelope it in its first stage of life. See ERPETOLOGY, p. 281.

TÆNIA, a genus of animals belonging to the class of *vermes*. See HELMINTHOLOGY, N° 29, 30.

TAFFETY, or TAFFETA, in *Commerce*, a fine smooth silken stuff, remarkably glossy. There are taffeties of all colours, some plain, and others striped with gold, silver, &c. others chequered, others flowered, &c. according to the fancy of the workmen.

TAGANROK, or TAGANROG, a sea-port town situated at the head of the sea of Azof, and forming one of the principal ports of the Russian empire. It stands on a small promontory, at the extremity of which is a fortress of considerable strength, and capable of accommodating a numerous garrison. The streets are wide but unpaved, and from the lightness of the soil, are either intolerably dusty, or ankle-deep in mud. The houses, which do not exceed a thousand, are small, built chiefly of wood, plaistered with mud, and roofed with bark. It is in north latitude 46°.

Taganrok is remarkable only as a place of trade, but in this view is highly respectable. When Mr M'Gill visited it in 1805, he found there upwards of 200 vessels of various sizes, waiting for cargoes. From its advantageous situation, at the head of the sea of Azof, and near the mouths of the rivers Don and Volga, and from its being in the vicinity of a very fertile country, it has become the centre of commerce for many staple articles. Hither are brought, for exportation, vast quantities of grain, wool, hides, butter, tallow, bees-wax, and honey from the southern provinces of Russia; iron, timber, pitch, and tar from Siberia; caviar to the amount of 50,000 puds annually from the Don and the Volga; hemp and flax from the neighbouring districts. Cordage and canvas are manufactured here, and form a considerable article of traffic. The trade is carried on chiefly by Ragusan and Greek supercargoes, who remain only till their commodities are collected and shipped. For the best accounts of this place, see Pallas's *Travels in the Russian Empire*, and M'Gill's *Travels in Turkey, Italy, and Russia*.

TAGARA, a city of ancient India, the metropolis of a large district called *Ariaca*, which comprehended the greatest part of the Subah of Aurungabad, and the southern part of Concan. Arrian says, that it was situated about ten days journey to the eastward of Pultanah; which, according to the rate of travelling in that country with loaded carts, might be about 100 British miles. This fixes its situation at Deoghir, a place of great antiquity, and famous through all India on account of the pagodas of Elousa. It is now called *Doulet-abad.*

TAGETES, MARYGOLD, a genus of plants belonging to the class syngenesia; and in the natural system ranking under the 49th order, *Compositæ*. See BOTANY *Index.*

TAGUS, the largest river of Spain; which, taking its rise on the confines of Arragon, runs south-west through the provinces of New Castile and Estremadura; and passing by the cities of Aranjuez, Toledo, and Alcantara, and then crossing Portugal, forms the harbour of Lisbon, at which city it is about three miles broad; and about eight or ten miles below this it falls into the Atlantic ocean.

TAHOEREWA, one of the Sandwich islands, is small, destitute of wood, the soil sandy and unfertile; is situated in north latitude 20° 38', in east longitude 203° 27'.

TAHOORA, one of the Sandwich islands in the South sea. It is uninhabited, and lies in north latitude 21° 43', and in east longitude 199° 36'. See SANDWICH-*Islands.*

TAJUCA, or PECCARY, in *Zoology*, a species of hog. See SUS, MAMMALIA *Index.*

TAI-OUAN, the Chinese name of the island of Formosa. See FORMOSA.—Tai-ouan is also the name of the capital of the island.

TAIL, the train of a beast, bird, or fish; which in land animals, it is said, serves to drive away flies, &c. and in birds and fishes to direct their course, and assist them in ascending or descending in the air or water. But the tail in all animals is of great use in directing their motions.

TAIL, or FEE-TAIL, in *Law*, is a conditional estate or fee, opposed to *fee-simple.* See FEE.

A conditional fee, at the common law, was a fee restrained to some particular heirs exclusive of others; as to the heirs of a man's body, by which only his lineal descendants were admitted, in exclusion of collateral heirs; or to the heirs male of his body, in exclusion both of collaterals and lineal females also. It was called a *conditional fee*, by reason of the condition expressed or implied in the donation of it, that if the donee died without such particular heirs, the land should revert to the donor. For this was a condition annexed by law to all grants whatsoever, that on failure of the heirs specified in the grant, the grant should be at an end, and the land return to its ancient proprietor. Such conditional fees were strictly agreeable to the nature of feuds, when they first ceased to be mere estates of life, and were not yet arrived to be absolute estates in fee-simple.

With regard to the condition annexed to these fees by the common law, it was held, that such a gift (to a man and the heirs of his body) was a gift upon condition that it should revert to the donor if the donee had no heirs of his body; but if he had, it should then remain to the donee. They therefore called it a *fee-simple* on condition that he had issue. Now we must observe, that when any condition is performed, it is thenceforth entirely gone; and the thing to which it was before annexed becomes absolute and wholly unconditional. So that as soon as the grantee had any issue born,

his

Tail. his estate was supposed to become absolute by the performance of the condition; at least for these three purposes: 1. To enable the tenant to alienate the land, and thereby to bar not only his own issue, but also the donor, of his interest in the reversion. 2. To subject him to forfeit it for treason: which he could not do till issue born longer than for his own life, lest thereby the inheritance of the issue and reversion of the donor might have been defeated. 3. To empower him to charge the land with rents, commons, and certain other encumbrances, so as to bind his issue. And this was thought the more reasonable, because, by the birth of issue, the possibility of the donor's reversion was rendered more distant and precarious: and his interest seems to have been the only one which the law, as it then stood, was solicitous to protect, without much regard to the right of succession intended to be vested in the issue. However, if the tenant did not in fact alienate the land, the course of descent was not altered by this performance of the condition; for if the issue had afterwards died, and then the tenant or original grantee had died, without making any alienation, the land, by the terms of the donation, could descend to none but the heirs of his body; and therefore, in default of them, must have reverted to the donor. For which reason, in order to subject the lands to the ordinary course of descent, the donees of these conditional fee-simples took care to alienate as soon as they had performed the condition by having issue; and afterwards repurchased the lands, which gave them a fee-simple absolute, that would descend to the heirs general, according to the course of the common law. And thus stood the old law with regard to conditional fees: which things, says Sir Edward Coke, though they seem ancient, are yet necessary to be known, as well for the declaring how the common law stood in such cases, as for the sake of annuities, and such-like inheritances, as are not within the statutes of entail, and therefore remain as the common law. The inconveniences which attended these limited and fettered inheritances were probably what induced the judges to give way to this subtle finesse (for such it undoubtedly was), in order to shorten the duration of these conditional estates. But, on the other hand, the nobility, who were willing to perpetuate their possessions in their own families, to put a stop to this practice, procured the statute of Westminster the second (commonly called the statute *de donis conditionalibus*) to be made; which paid a greater regard to the private will and intentions of the donor, than to the propriety of such intentions, or any public considerations whatsoever. This statute revived in some sort the ancient feodal restraints which were originally laid on alienations, by enacting, that from thenceforth the will of the donor be observed; and that the tenements so given (to a man and the heirs of his body) should at all events go to the issue, if there were any; or if none, should revert to the donor.

Upon the construction of this act of parliament, the judges determined that the donee had no longer a conditional fee-simple, which became absolute and at his own disposal the instant any issue was born; but they divided the estate into two parts, leaving the donee a new kind of particular estate, which they denominated a *fee-tail;* and vesting in the donor the ultimate fee-simple of the land, expectant on the failure of issue; which expectant estate is what we now call a *reversion.* And hence it is that Littleton tells us, that tenant in fee-tail is by virtue of the statute of Westminster the second. The expression *fee-tail*, or *feodum talliatum*, was borrowed from the feudists (see Crag. *l. s. t.* 10. § 24, 25.), among whom it signified any mutilated or truncated inheritance, from which the heirs general were cut off; being derived from the barbarous verb *taliare*, to cut; from which the French *tailler* and the Italian *tagliare* are formed, (Spelm. *Gloss.* 531.). Tail.

Having thus shown the original of estates tail, we now proceed to consider what things may or may not be entailed under the statute *de donis*. Tenements is the only word used in the statute: and this Sir Edward Coke expounds to comprehend all corporeal hereditaments whatsoever: and also all incorporeal hereditaments which savour of the reality, that is, which issue out of corporeal ones, or which concern or are annexed to or may be exercised within the same; as rents, estovers, commons, and the like. Also offices and dignities, which concern lands, or have relation to fixed and certain places, may be entailed. But mere personal chattels, which savour not at all of the reality, canno tbe entailed. Neither can an office, which merely relates to such personal chattels; nor an annuity, which charges only the person, and not the lands of the granter. But in these last, if granted to a man and the heirs of his body, the grantee hath still a fee conditional at common law as before the statute, and by his alienation may bar the heir or reversioner. An estate to a man and his heirs for another's life cannot be entailed; for this is strictly no estate of inheritance, and therefore not within the statute *de donis*. Neither can a copyhold estate be entailed by virtue of the statute; for that would tend to encroach upon and restrain the will of the lord; but, by the special custom of the manor, a copyhold may be limited to the heirs of the body; for here the custom ascertains and interprets the lord's will.

As to the several species of estates-tail, and how they are respectively created; they are either general or special. Tail-general is where lands and tenements are given to one, and the heirs of his body begotten: which is called *tail-general;* because, how often soever such donee in tail be married, his issue in general, by all and every such marriage, is, in successive order, capable of inheriting the estate-tail *per formam doni.* Tenant in *tail-special* is where the gift is restrained to certain heirs of the donee's body, and does not go to all of them in general. And this may happen several ways. We shall instance in only one; as where lands and tenements are given to a man and the heirs of his body, on Mary his now wife to be begotten. Here no issue can inherit but such special issue as is engendered between them two; not such as the husband may have by another wife; and therefore it is called *special tail.* And here we may observe, that the words of inheritance (to him and his heirs) give him an estate in fee; but they being heirs to be by him begotten, this makes it a fee tail; and the person being also limited, on whom such heirs shall be begotten (viz. Mary his present wife), this makes it a fee-tail special.

Estates in general and special tail are farther diversified by the distinction of sexes in such entails; for both of them may either be in tail male or tail female. As if

Tail. if lands be given to a man, and his heirs-male of his body begotten, this is an estate in tail male general; but if to a man, and the heirs-female of his body on his present wife begotten, this is an estate in tail female special. And in case of an entail male, the heirs-female shall never inherit, nor any derived from them; nor, *è converso*, the heirs-male in case of a gift in tail female. Thus, if the donee in tail male hath a daughter, who dies leaving a son, such grandson in this case cannot inherit the estate tail; for he cannot deduce his descent wholly by heirs-male. And as the heir-male must convey his descent wholly by males, so must the heir-female wholly by females. And therefore if a man hath two estates-tail, the one in tail male and the other in tail female, and he hath issue a daughter, which daughter hath issue a son; this grandson can succeed to neither of the estates, for he cannot convey his descent wholly either in the male or female line.

As the word *heirs* is necessary to create a fee, so, in farther imitation of the strictness of the feodal donation, the word *body*, or some other words of procreation, are necessary to make it a fee-tail, and ascertain to what heirs in particular the fee is limited. If, therefore, either the words of inheritance or words of procreation be omitted, albeit the others are inserted in the grant, this will not make an estate-tail. As if the grant be to a man and the issue of his body, to a man and his seed, to a man and his children or offspring; all these are only estates for life, there wanting the words of inheritance, "his heirs." So, on the other hand, a gift to a man, and his heirs male or female, is an estate in fee-simple and not in fee-tail; for there are no words to ascertain the body out of which they shall issue. Indeed, in last wills and testaments, wherein greater indulgence is allowed, an estate-tail may be created by a devise to a man and his seed, or to a man and his heirs male, or by other irregular modes of expression.

There is still another species of entailed estates, now indeed grown out of use, yet still capable of subsisting in law; which are estates *in libero maritagio*, or FRANK-MARRIAGE. See that article.

The incidents to a tenancy in tail, under the statute Wesminster 2. are chiefly these: 1. That a tenant in tail may commit waste on the estate-tail, by felling timber, pulling down houses, or the like, without being impeached or called to account for the same. 2. That the wife of the tenant in tail shall have her dower, or thirds, of the estate-tail. 3. That the husband of a female tenant in tail may be tenant by the curtesy of the estate-tail. 4. That an estate-tail may be barred, or destroyed, by a fine, by a common recovery, or by lineal warranty descending with assets to the heir. See ASSETS.

Thus much for the nature of estates-tail: the establishment of which family law (as it is properly styled by Pigott) occasioned infinite difficulties and disputes. Children grew disobedient when they knew they could not be set aside: farmers were ousted of their leases made by tenants in tail; for if such leases had been valid, then, under colour of long leases, the issue might have been virtually disinherited: creditors were defrauded of their debts; for, if a tenant in tail could have charged his estate with their payment, he might also have defeated his issue, by mortgaging it for as much as it was worth: innumerable latent entails were produced to deprive purchasers of the lands they had fairly brought; of suits in consequence of which, our ancient books are full: and treasons were encouraged, as estates-tail were not liable to forfeiture longer than for the tenant's life. So that they were justly branded as the source of new contentions and mischiefs unknown to the common law; and almost universally considered as the common grievance of the realm. But as the nobility were always fond of this statute, because it preserved their family estates from forfeiture, there was little hope of procuring a repeal by the legislature; and therefore, by the connivance of an active and politic prince, a method was devised to evade it.

About 200 years intervened between the making of the statute *de donis*, and the application of common recoveries to this intent, in the 12th year of Edward IV.; which were then openly declared by the judges to be a sufficient bar of an estate-tail. For though the courts had, so long before as the reign of Edward III. very frequently hinted their opinion that a bar might be effected upon these principles, yet it was never carried into execution; till Edward IV. observing (in the disputes between the houses of York and Lancaster) how little effect attainders for treason had on families whose estates were protected by the sanctuary of entails, gave his countenance to this proceeding, and suffered Taltarum's case to be brought before the court: wherein, in consequence of the principles then laid down, it was in effect determined, that a common recovery suffered by tenant in tail should be an effectual destruction thereof. These common recoveries are fictitious proceedings, introduced by a kind of *pia fraus*, to elude the statute *de donis*, which was found so intolerably mischievous, and which yet one branch of the legislature would not then consent to repeal; and that these recoveries, however clandestinely begun, are now become by long use and acquiescence a most common assurance of lands; and are looked upon as the legal mode of conveyance, by which a tenant in tail may dispose of his lands and tenements: so that no court will suffer them to be shaken or reflected on, and even acts of parliament have by a side-wind countenanced and established them.

This expedient having greatly abridged estates-tail with regard to their duration, others were soon invented to strip them of other privileges. The next that was attacked was their freedom from forfeitures for treason. For, notwithstanding the large advances made by recoveries, in the compass of about threescore years, towards unfettering these inheritances, and thereby subjecting the lands to forfeiture, the rapacious prince then reigning, finding them frequently resettled in a similar manner to suit the convenience of families, had address enough to procure a statute, whereby all estates of inheritance (under which general words estates-tail were covertly included) are declared to be forfeited to the king upon any conviction of high-treason.

The next attack which they suffered, in order of time, was by the statute 32 Hen. VIII. c. 28. whereby certain leases made by tenants in tail, which do not tend to the prejudice of the issue, were allowed to be good in law, and to bind the issue in tail. But they received a more violent blow in the same session of parliament, by the construction put upon the statute of fines, by the statute 32 Hen. VIII. c. 36. which declares a fine duly levied by tenant in tail to be a complete bar to him and his heirs, and all other persons claiming under such entail.

entail. This was evidently agreeable to the intention of Henry VII. whose policy it was (before common recoveries had obtained their full strength and authority) to lay the road as open as possible to the alienation of landed property, in order to weaken the overgrown power of his nobles. But as they, from the opposite reasons, were not easily brought to consent to such a provision, it was therefore couched, in his act, under covert and obscure expressions. And the judges, though willing to construe that statute as favourably as possible for the defeating of entailed estates, yet hesitated at giving fines so extensive a power by mere implication, when the statute *de donis* had expressly declared that they should not be a bar to estates-tail. But the statute of Henry VIII. when the doctrine of alienation was better received, and the will of the prince more implicitly obeyed than before, avowed and established that intention. Yet, in order to preserve the property of the crown from any danger of infringement, all estates-tail created by the crown, and of which the crown has the reversion, are excepted out of this statute. And the same was done with regard to common recoveries, by the statute 34 and 35 Hen. VIII. c. 28. which enacts, that no feigned recovery had against tenants in tail, where the estate was created by the crown, and the remainder or reversion continues still in the crown, shall be of any force and effect. Which is allowing, indirectly and collaterally, their full force and effect with respect to ordinary estates-tail, where the royal prerogative is not concerned.

Lastly, by a statute of the succeeding year, all estates-tail are rendered liable to be charged for payment of debts due to the king by record or special contract; as since, by the bankrupt laws, they are also subjected to be sold for the debts contracted by a bankrupt. And by the construction put on the statute 43 Eliz. c. 4. an appointment by tenant in tail of the lands entailed to a charitable use is good without fine or recovery.

Estates-tail being thus by degrees unfettered, are now reduced again to almost the same state, even before issue born, as conditional fees were in at common law, after the condition was performed by the birth of issue. For, first, the tenant in tail is now enabled to alienate his lands and tenements by fine, by recovery, or by certain other means; and thereby to defeat the interest as well of his own issue, though unborn, as also of the reversioner, except in the case of the crown: secondly, he is now liable to forfeit them for high treason: and, lastly, he may charge them with reasonable leases, and also with such of his debts as are due to the crown on specialties, or have been contracted with his fellow-subjects in a course of extensive commerce.

TAILZIE, in *Scots Law*, the same with Tail. See Law, N° clxxx. 9.

TALAPOINS or Talopins, priests of Siam.—They enjoy great privileges, but are enjoined celibacy and austerity of life. They live in monasteries contiguous to the temples: and what is singular, any one may enter into the priesthood, and after a certain age may quit it to marry, and return to society. There are talapoinesses too, or nuns, who live in the same convents, but are not admitted till they have passed their fortieth year. The talapoins educate children; and at every new and full moon explain the precepts of their religion in their temples; and during the rainy season they preach from six in the morning till noon, and from one in the afternoon till five in the evening. They dress in a very mean garb, go bareheaded and barefooted; and no person is admitted among them who is not well skilled in the Baly language.

They believe that the universe is eternal; but admit that certain parts of it, as this world, may be destroyed and again regenerated. They believe in a universal pervading spirit, and in the immortality and transmigration of the soul; but they extend this last doctrine, not only to all animals, but to vegetables and rocks. They have their good and evil genii, and particular deities, who preside over forests and rivers, and interfere in all sublunary affairs.

For the honour of human nature, we are happy to find so pure a system of morality prevail among these people: It not only forbids its followers to do ill, but enjoins the necessity of doing good, and of stifling every improper thought or criminal desire.

Those who wish to peruse a more particular account of the Talapoins, may consult *Voyage de M. de la Loubere;* and Sketches relating to the History, &c. of the Hindoos.

TALC, a species of mineral arranged under the magnesian earths. See Mineralogy *Index*.

TALENT, signifies both a weight and a coin very common among the ancients, but very different among different nations.

The common Attic talent of weight contains 60 Attic minæ, or 6000 Attic drachmæ; and weighed, according to Dr Arbuthnot, 59 lbs. 11 oz. $17\frac{1}{7}$ gr. English Troy weight. There was another Attic talent, by some said to consist of 80, by others of 100 minæ. The Egyptian talent was 80 minæ; the Antiochian also 80; the Ptolemaic of Cleopatra $86\frac{2}{3}$; that of Alexandria 96; and the Insular talent 120. In the valuation of money, the Grecian talent, according to Dr Arbuthnot, was equal to 60 minæ, or, reckoning the mina at 3l. 4s. 7d. equal to 193l. 15s. The Syrian talent, in this valuation, consisted of 15 Attic minæ; the Ptolemaic of 20; the Antiochian of 60; the Euboic of 60; the Babylonic of 70; the Greater Attic of 80; the Tyrian of 80; the Eginean of 100; the Rhodian of 100; and the Egyptian of 80 minæ.

There is another talent much more ancient, which Dr Arbuthnot calls the *Homeric talent* of gold, which seems to have weighed six Attic drachms or three darics, a daric weighing very little more than a guinea. According to this talent, some reckon the treasure of King David, particularly that mentioned 1 Chron. xxii. 14. which, according to the common reckoning, would amount in gold talents to the value of 547,500,000l. and the silver to above 342,000,000l.; or, reckoning according to the decuple proportion of gold to silver, the two sums would be equal. As David reigned in Judæa after the siege of Troy, it is not improbable but Homer and he might use the same numeral talent of gold.

Among the Romans there were two kinds of talents, the *little* and the *great* talent: the little was the common talent; and whenever they say simply *talentum*, they are to be understood of this. The little talent was 60 minæ or Roman pounds; the mina or pound estimated at 100 drachmæ or denarii: it was also estimated at 24 great sesterces, which amounted to 60 pounds.

The great talent exceeded the less by one-third part.

Budæus

Budæus computes, that the little talent of silver was worth 75l. sterling, and the greater 99l. 6s. 8d. sterling. The greater of gold was worth 1125l. sterling.

TALENT, as a species or money, among the Hebrews, was sometimes used for a gold coin, the same with the shekel of gold, called also *stater*, and weighing only four drachms. The Hebrews reckoned by these talents as we do by pounds, &c. Thus a million of gold, or million of talents of gold, among them, was a million of shekels or nummi; the nummus of gold being the same weight with the shekel, viz. four drachms.

But the Hebrew talent weight of silver, which they called *cicar*, was equivalent to that of 3000 shekels, or 113 lb. 10 oz. 1 dwt. $10\frac{2}{7}$ gr. English Troy weight, according to Arbuthnot's computation.

TALIACOTIUS, GASPAR, chief surgeon to the great duke of Tuscany, was born at Bononia in Italy in 1553. He wrote a Latin treatise entitled *Chirurgia Nota de Curtis Membris*, in which he teaches the art of engrafting noses, ears, lips, &c. giving representations of the instruments and proper bandages; many, however, are of opinion that he never put his art in practice. But his doctrine is not singular; for Alexander Benedictus, a famous chirurgical writer, has described a similar operation.

TALIO, (*lex talionis*), a species of punishment in the Mosaic law, whereby an evil is returned similar to that committed against us by another; hence that expression, "Eye for eye, tooth for tooth." This law was at first inserted in the 12 tables amongst the Romans; but afterwards set aside, and a power given to the prætor to fix upon a sum of money for the damage done.

TALISMANS, magical figures cut or engraved with superstitious observations on the characterisms and configurations of the heavens, to which some astrologers have attributed wonderful virtues, particularly that of calling down celestial influences. The talismans of Samothrace, so famous of old, were pieces of iron formed into certain images, and set in rings; these were esteemed preservatives against all kinds of evils. There were likewise talismans taken from vegetables, and others from minerals.

TALLAGE, (*tallagium*), from the French *taillé*, is metaphorically used for a part or share of a man's substance carved out of the whole, paid by way of tribute, toll, or tax.

TALLOW, in *Commerce*, the fat of certain animals melted and clarified. It is procured from most animals, but chiefly from bullocks, sheep, hogs, and bears. Some kinds of tallow are used as unguents in medicine, some for making soap and dressing leather, and some for making candles. See FAT, CHEMISTRY *Index*.

TALLOW-Tree. See CROTON, BOTANY *Index*.

TALLY, is a stick cut in two parts, on each whereof is marked, with notches or otherwise, what is due between debtor and creditor, as now used by brewers, &c. And this was the ancient way of keeping all accounts, one part being kept by the creditor, the other by the debtor, &c. Hence the tallier of the exchequer, whom we now call the *teller*. But there are two kinds of tallies mentioned in our statutes to have been long used in the exchequer. The one is termed *tallies of debt*, which are in the nature of an acquittance for debts paid to the king, on the payment whereof these tallies are delivered to the debtors, who carrying them to the clerk of the pipe-office, have there an acquittance in parchment for their full discharge. The other are *tallies of reward* or allowance, being made to sheriffs of counties as a recompense for such matters as they have performed to their charge, or such money as is cast upon them in their accounts of course, but not leviable, &c. In the exchequer there is a tally-court, where attend the two deputy-chamberlains of the exchequer and the tally-cutter: and a tally is generally the king's acquittance for money paid or lent, and has written on it words proper to express on what occasion the money is received.

TALLY-Man, a person that sells or lets goods, clothes, &c. to be paid by so much a-week.

TALMUD, a collection of Jewish traditions. There are two works which bear this name, the Talmud of Jerusalem, and the Talmud of Babylon. Each of these is composed of two parts; the Mishna, which is the text, and is common to both, and the Gemara or commentary. See MISHNA and GEMARA.

The Mishna, which comprehends all the laws, institutions, and rules of life which, beside the ancient Hebrew scripture, the Jews thought themselves bound to observe, was composed, according to the unanimous testimony of the Jews, about the close of the second century. It was the work of Rabbi Jehuda (or Juda) Hakkadosh, who was the ornament of the school at Tiberias, and is said to have occupied him forty years. The commentaries and additions which succeeding Rabbis made were collected by Rabbi Jochanan Ben Eliezer, some say in the 5th, others say in the 6th, and others in the 7th century, under the name of *Gemara*, that is, *completion*; because it completed the Talmud. A similar addition was made to the Mishna by the Babylonish doctors in the beginning of the 6th century according to Enfield, and in the 7th according to others.

The Mishna is divided into six parts, of which every one which is entitled *order* is formed of treatises, every treatise is divided into chapters, and every chapter into mishnas or aphorisms. In the *first* part is discussed whatever relates to seeds, fruits, and trees: in the *second* feasts: in the *third* women, their duties, their disorders, marriages, divorces, contracts, and nuptials: in the *fourth* are treated the damages or losses sustained by beasts or men, of things found, deposits, usuries, rents, farms, partnerships in commerce, inheritance, sales and purchases, oaths, witnesses, arrests, idolatry; and here are named those by whom the oral law was received and preserved: in the *fifth* part are noticed what regards sacrifices and holy things: and the *sixth* treats on purifications, vessels, furniture, clothes, houses, leprosy, baths, and numerous other articles. All this forms the Mishna.

As the learned reader may wish to obtain some notion of rabbinical composition and judgment, we shall gratify his curiosity sufficiently by the following specimen: "Adam's *body* was made of the earth of Babylon, his *head* of the land of Israel, his other *members* of other parts of the world. R. Meir thought he was compact of the earth gathered out of the whole earth; as it is written, *thine eyes did see my substance*. Now it is elsewhere written, *the eyes of the Lord are over all the earth*. R. Aha expressly marks the twelve hours in which his various parts were formed. His stature was from one end of the world to the other; and it was for his transgression that the Creator, laying his hand in anger on him, lessened

sened him; for before (says R. Eleazar), 'with his hands he reached the firmament.' R. Jehuda thinks his sin was heresy; but R. Isaac thinks that 'it was nourishing his foreskin.'

The Talmud of Babylon is most valued by the Jews; and this is the book which they mean to express when they talk of the Talmud in general. An abridgement of it was made by Maimonides in the 12th century, in which he rejected some of its greatest absurdities. The Gemara is stuffed with dreams and chimeras, with many ignorant and impertinent questions, and the style very coarse. The Mishna is written in a style comparatively pure, and may be very useful in explaining passages of the New Testament where the phraseology is similar. This is indeed the only use to which Christians can apply it; but this renders it valuable. Lightfoot had judiciously availed himself of such information as he could derive from it. Some of the popes, with a barbarous zeal, and a timidity of spirit for the success of the Christian religion, which the belief of its divinity can never excuse, ordered great numbers of the Talmud to be burned. Gregory IX. burned about 20 cart-loads, and Paul IV. ordered 12,000 copies of the Talmud to be destroyed.

The last edition of the Talmud of Babylon, printed at Amsterdam, is in 12 vols folio. The Talmud of Jerusalem is in one large folio.

TALPA, the MOLE; a genus of quadrupeds belonging to the order of *feræ*. See MAMMALIA *Index*.

TAMANDAU. See MYRMECOPHAGA, MAMMALIA *Index*.

TAMARUNDIS, the TAMARIND-TREE; a genus of plants; according to Linnæus belonging to the class of triandria; but Woodville, Schreber, and other botanists, have arranged it under the class of monadelphia. See BOTANY *Index*.

TAMARIX, the TAMARISC, a genus of plants belonging to the class pentandria; and in the natural system ranging under the 13th order, *Succulentæ*. See BOTANY *Index*.

TAMBOUR, in *Architecture*, a term applied to the Corinthian and Composite capitals, as bearing some resemblance to a drum, which the French call *tambour*. Some choose to call it the *vase*, and others *campana* or the bell.

TAMBOUR is also used for a little box of timber work, covered with a ceiling, withinside the porch of certain churches; both to prevent the view of persons passing by, and to keep off the wind, &c. by means of folding-doors, &c.

TAMBOUR, also denotes a round course of stone, several whereof form the shaft of a column, not so high as a diameter.

TAMBOUR, in the arts is a species of embroidery. The tambour is an instrument of a spherical form, upon which is stretched, by means of a string and buckle, or other suitable appendage, a piece of linen or thin silken stuff; which is wrought with a needle of a particular form, and by means of silken or gold and silver threads, into leaves, flowers, or other figures.

TAMBOURIN, is the name of a dance performed on the French stage. The air is lively, and the movements are quick.

The same name is applied to a musical instrument, formed of a hoop, over which is stretched a piece of parchment or vellum, while bells and hollow hemispheres of brass are loosely hung in holes cut in the hoop. The tambourin is used only as an accompaniment to other instruments.

TAMERLANE, or TIMUR BEK, a celebrated prince and conqueror. At the age of 25 he attained the highest dignities, with surprising courage, and an ambition astonishing to all the world. Endeavouring to perfect the great talents which he had received from nature, he spent nine years in different countries; where his great sense and elevated genius appeared in councils and assemblies, while his intrepidity and valour, whether in personal combats or pitched battles, drew upon him the admiration of all mankind. He made himself master of the three empires of Jagatay Khân, Tushi Khân, and Hûlâkû Khân; so that his power, riches, and magnificence, were immense. There remain vast monuments of his grandeur in the cities, towns, castles, and walls, which he built; in the rivers and canals which he dug, as well as the bridges, gardens, palaces, hospitals, mosques, and monasteries, which he erected in divers parts of Asia in so great a number, that a king might be accounted very powerful and magnificent, who should have employed 36 years only in building the great edifices which Timûr caused to be founded.

Timûr, according to the historian Arabshâh, was in his person very corpulent and tall. He had a large forehead and big head. His countenance was agreeable, and his complexion fair. He wore a large beard, was very strong and well limbed; had broad shoulders, thick fingers, and long legs. His constitution was amazingly vigorous; but he was maimed in one hand and lame of the right side. His eyes appeared full of fire; his voice was loud and piercing; he feared nothing; and when far advanced in years, his understanding was sound and perfect, his body vigorous and robust, his mind constant and unshaken like a rock.

He did not like raillery, and could not bear a lie. There was no joking or fooling before him; for he loved the naked truth, even although it was to his own disadvantage. He neither grieved if he miscarried in any attempt, nor appeared overjoyed on any great success. The device of his seal was, "I am sincere and plain." He had a clear and solid understanding, was surprisingly happy in his conjectures; vigilant, active, and unshaken in his resolutions. He took great delight in reading history, and was well versed in the state of countries, provinces, and cities. He was penetrating, subtle, close, and dissembling; just by inclination, liberal from disposition; but ambition had in a great measure extinguished his humanity: war had familiarized him to blood; and his religious zeal had inspired him with the most cruel, implacable, and pernicious fanaticism.

He died on the 1st of April 1405, in the 71st year of his age and 36th of his reign. When he found death approaching, he sent for his principal officers, declared his grandson his heir, and made them swear to execute his will. Having recommended brotherly love and concord to the princes his children, he ordered one of the doctors to read the Koran at his bed's head, and often repeat the unity of God. At night he several times made profession of his belief, "That there is no other God than God," and then expired. See MOGULS, N° 15, &c.

TAMTAM, a flat drum used by the Hindoos, resembling a tabor, but it is larger, and sounds louder.

TAMUS, BLACK BRIONY, a genus of plants belonging

ing to the class diœcia; and in the natural system ranking under the 11th order, *Sarmentaceæ*. See BOTANY *Index*.

TAN, the bark of the oak after it has been ground and used by the tanner. The smallest sort is generally made up in little square cakes called *turf*, and sold for firing. The coarser sort is sometimes dried in the sun, and used by bakers for heating their ovens, &c. but its chief use is for making hot-beds to raise pine-apples and other plants.—William III. introduced the use of it from Holland, for the purpose of raising orange trees; after which it was discontinued for many years: but about 1719, when *ananas* were first brought into England, it came into general use, and has ever since been in great estimation with gardeners for all the purposes of forcing, &c. on account of its strong and lasting fermentation. The smaller the tan the quicker it heats; but the larger sort acquires heat more gradually and retains it longer: the skilful gardener therefore uses the one or the other, or a mixture of both, according to the time and purpose for which it is wanted. It is some time after the tan comes out of the tanner's pit before it begins to heat, and therefore it is not fit for immediate use; but having lain a week or two, it enters into a state of fermentation, and if put into hot-beds properly prepared, will retain a moderate heat for three or four months. When it becomes useless for the hot-house, it is said by Miller and others to be an excellent manure for some kinds of land.

The word *tan* is sometimes, though improperly, used for the *bark* itself, which is the chief ingredient in the tanning of leather. Oak bark, on account of its great astringency and gummy-resinous properties, is preferred to all other substances for the purpose of tanning, as it not only preserves the leather from rotting, but also, by condensing the pores, renders it impervious to water. See TANNING.

For an account of tan or *tannin*, considered as a chemical principle, see CHEMISTRY, N° 2504.

TANACETUM, TANSY, a genus of plants belonging to the class syngenesia; and in the natural system ranging under the 49th order, *Compositæ*. See BOTANY *Index*.

TANÆCIUM, a genus of plants belonging to the didynamia class; and in the natural method ranking under the 25th order, *Putamineæ*. See BOTANY *Index*.

TANAGRA, TANAGER, a genus of birds belonging to the order of *passeres*. See ORNITHOLOGY *Index*.

TANAIS, or DON. See DON.

TANGENT *of an* ARCH, is a right line drawn perpendicularly from the end of a diameter, passing to one extremity of the arch, and terminated by a right line drawn from the centre through the other end of that arch, and called the *secant*. See GEOMETRY.

TANGIER, a port-town of Africa, in the empire of Morocco and kingdom of Fez, situated at the entrance of the straits of Gibraltar, in W. Long. 5. 50. N. Lat. 38. 49. In 1662, this place belonged to the Portuguese, and was given to King Charles II. upon his marriage with the Infanta of Portugal; but, he growing weary of the charge of keeping it, caused it to be blown up and destroyed in 1684; ever since which time it has been only a poor fishing town. Anciently it was called *Tingis*, and gave name to the province of Mauritania Tingitana.

TANK, in the language of Indostan, a place inclosed for receiving and retaining rain water. During the periodical rains the tanks are filled, and thus in the dry season furnish water for the rice fields and cattle. Some of them are of great extent, measuring 300 or 400 feet on the side; they are of a quadrangular form, and lined with granite, descending in regular steps from the margin to the bottom.

TANNER, one who dresses hides by tanning them. See TANNING.

TANNER, *Dr Thomas*, an English prelate and celebrated antiquarian, born in 1674. He was admitted of Queen's college Oxford, where a similarity of taste for antiquities produced a close friendship between him and Edmund Gibson afterwards bishop of London. In 1697, he was chosen fellow of his college; and having already published some specimens of his antiquarian researches; soon after became known to Dr Moore bishop of Norwich, who made him chancellor of his diocese. In 1722, he was made archdeacon of Norwich, and in 1731, bishop of St Asaph. He died at Oxford in 1735; and after his death was published an elaborate work, in which he is said to have been employed for 40 years, under this title, *Bibliotheca Britannica Hibernica, sive de Scriptoribus qui in Anglia, Scotia, et Hibernia, ad sæculi* XVII. *initium floruerunt*, &c.

TANNING, the art of converting hides and skins into leather. This art has been practised for many centuries in Britain; but some improvements have been made on it, especially in France, suggested by the discoveries of modern chemistry. These improvements we shall briefly notice after having described the method lately practised in the neighbourhood of London, where the best British leather is manufactured. The general principles on which the improvements are founded, will naturally come to be considered, after describing the processes themselves.

1 Different kinds of leather.

The leather tanned in England is generally divided by the manufacturers into three kinds, *butts* or *backs*, *hides*, and *skins*. *Butts* are made from the stoutest and heaviest ox hides, and are used chiefly for the soles of stout shoes and boots. *Hides*, or *crop-hides*, are made from cow hides, or the lighter ox hides, and are employed for ordinary soles. The term *skins* is applied to all the other kinds of leather, comprehending that made from the skins of calves, seals, dogs, kids, &c.

2 Method of tanning butts.

Butts are tanned as follows. After the horns are taken off, the hides are laid smooth in heaps for two days in summer, and five or six in winter; they are then hung on poles in a close room, called a smoke-house, in which is kept a smouldering fire of wet tan; this occasions a small degree of putrefaction, by which means the hair more easily comes off, by spreading the hide on a sort of wooden horse or beam, and scraping it with a crooked knife. The hair being taken off, the hide is thrown into a pool of water, to cleanse it from the dirt, &c. which being done, it is again spread on the wooden beam, and the grease, loose flesh, extraneous filth, &c. carefully taken off: the hides are then put into a pit of strong liquor, called *ooze*, prepared in pits kept for the purpose, by infusing ground oak bark in water, which is termed *colouring*. The hides are then removed into another pit, called a *scouring*, which consists of water strongly impregnated with vitriolic or sulphuric acid, or a vegetable acid prepared from rye or barley. This operation

Tanning. operation is called *raising*. The hides are then taken out of the scouring, and spread smooth in a pit usually filled with water, called a *binder*, with a quantity of ground bark strewed between each. After lying a month or six weeks, they are taken up, and the decayed bark and liquor being drawn out of the pit, it is again filled with strong ooze, when they are put in as before, with bark between each hide. They now lie two or three months, at the expiration of which the same operation is repeated; they then remain four or five months, when they again undergo the same process, and after being three months in the last pit, are completely tanned, unless the hides are so remarkably stout as to require an additional pit or layer. The whole process requires from 11 to 18 months, and sometimes two years, according to the substance of the hide, and discretion of the tanner. When taken out of the pit to be dried, they are hung on poles; and after being compressed by a steel pin, and beaten out smooth by wooden beetles, the operation is completed.

3 Of tanning hides.

Hides are thus managed. After the horns are taken off, and the hide is washed, they are put into a pit of water, saturated with lime, and having mixed with it a quantity of the same substance, where they remain a few days, when they are taken out, and the hair scraped off on a wooden beam, as before described; they are then washed in a pit or pool of water, and the loose flesh, &c. being taken off, they are removed into a pit of weak ooze, where they are taken up and put down two or three times a day, for the first week; every second or third day they are shifted into a pit of fresh ooze, somewhat stronger than the former, till at the end of a month or six weeks they are put into a strong ooze, in which they are handled once or twice a week with fresh bark for two or three months. They are then removed into another pit, called a *layer*, in which they are laid smooth, with bark ground very fine, strewed above each hide. After remaining here two or three months, they are generally taken up, when the ooze is withdrawn, and the hides put in again with fresh ooze and fresh bark, where, after lying two or three months more, they are completely tanned; except a very few stout hides which may require an extra layer. They are then taken out and hung on poles, and being smoothed by a steel pin, are, when dry, ready for sale.

4 Of tanning skins.

Skins are to be washed in water, &c. and put into lime pits as before mentioned, where they are taken up and put down every third or fourth day for two or three weeks, in order to destroy the scarf-skin. The hair is then scraped off, and the excrescences being removed, they are put into a pit of water impregnated with pigeons dung, called a *grainer*, which in a week or 10 days soaking out the lime, grease, and saponaceous matter, softens the skins, and prepares them for the reception of the ooze. They are then put into a pit of weak ooze, in the same manner as the hides, and being frequently handled, are by degrees removed into a stronger, and still stronger liquor, for a month or six weeks, when they are put into a very strong ooze, with fresh bark ground very fine, and at the end of two or three months, according to their substances, are sufficiently tanned; when they are taken out, hung on poles, and dried.

The lighter sorts of hides, called *dressing hides*, as well as horse hides, are managed nearly in the same manner as skins, and are used for coach work, harness work, &c.

4 Objections to the old methods.

The principal objections to this old method of tanning are, that it is extremely tedious, and very expensive. Various means have been suggested for introducing a cheaper and more expeditious method of tanning. Among the earliest of these we may notice that of Dr Macbride.

5 Dr Macbride's improvement.

This method consists chiefly in the use of sulphuric instead of acetous acid, for raising or distending the pores of the leather, and in substituting lime water, or a solution of lime, for what has been called the *milk* of lime, or a considerable quantity of lime diffused in water. According to a report made to the committee of commerce of the Dublin society, it appeared that Dr Macbride's method produced a saving of more than 20 per cent. to the manufacturer, while the hides were completely tanned in a much shorter time. It does not appear, however, that this method ever came into general use.

The experiments of M. Seguin, made in the end of the 18th century, on the nature of the tanning principle led him to suggest a method of tanning which is certainly much more expeditious than the old method. It has been adopted in England by Mr William Desmond, and by his directions has been practised with considerable success, by some of the principal tanners in Warwickshire, Staffordshire, and some of the neighbouring counties. The following directions, communicated by Mr Desmond to the editor of the Philosophical Magazine, will sufficiently explain this new process.

6 Mr Desmond's method.

Provide five vessels, called *digesters*, of any convenient materials and dimensions, with an aperture at the bottom of each. Let them be placed near each other, and elevated on stillages or otherwise; so that a small vessel may be placed under them. Fill the digesters with tan, viz. the bark of certain trees, such as of oak, cut small, or ground to a coarse powder. Pour water on the tan in the first digester, where it may stand some time, or be immediately drawn off. This liquor is to be poured on the tan in the second digester; from that to the third, and so on, until it comes through the tan in the last digester. The liquor is then highly coloured, and marks from 6° to 8° on the hydrometer for salts. This liquor is to be used for tanning the thickest hides, and may be called the *tanning lixivium*. If you take a small quantity of it in a glass, and pour on it a few drops of a solution of animal glue, the clear liquor becomes turbid, and a whitish substance falls to the bottom. The precipitate thus obtained, is a sure indication that the liquor contains the tanning principle; for this reason, that glue being of the same nature with the skins or hides of which it is made, whatever substance unites itself indissolubly with the former, will do so likewise with the latter.

This solution is made by dissolving a little common glue in water over a moderate fire; by means of it, not only oak bark, but also the bark of several other trees, as well as different shrubs and plants, all which may be called *tan*, are found to contain the tanning principle; and by employing the solution as before, it will be always easy to ascertain whether any given substance contains this principle.

In the course of these lixiviations it may be observed, 1. That the liquor running from the first digester, at length

Tanning.

length loses its colour. If in this state a little of it be put into a glass, and the former experiment be repeated, the liquor no longer becomes turbid, but remains clear, which shews that it contains no more of the tanning principle; but if a few drops of a solution of sulphate of iron be poured into the same glass, the liquor becomes thick and black, which is not to be poured on the tan in the second digester, but afterwards used for taking off the hair or wool. It is known by the name of *gallic lixivium*, as it appears to contain the same principles with galls.

The liquid sulphate of iron is obtained by dissolving a small quantity of iron in diluted sulphuric acid, or by dissolving green copperas in water. This solution serves to ascertain such substances as contain the gallic principle. Lime water will also produce this effect.

When the liquor ceases to grow black by the mixture of the sulphate of iron, it will be in vain to pour any more water on the tan in the first digester. This tan being thus exhausted, must be removed, and new tan put in its place.

The liquor, after running through all the digesters, at last grows weak. All the liquor that marks from 6° to 8° on the hydrometer, must be added to the stock of tanning lixivium. What proceeds afterwards from the last digester is to be poured on the new tan in the first. Then the fresh water is to be conveyed on the tan in the second digester, and the liquor of the first set aside, while it marks 6° or 8° on the hydrometer, and added to the tanning lixivium, which must always be carefully separated from the gallic. In this manner, the tan in all the digesters may be renewed, and the lixiviations continued.

The number of these lixiviations, as well as the mode of making them, may be varied at pleasure; the essential point is to repeat them so as to give the liquor a sufficient degree of concentration, which may be determined by the hydrometer, and proportioned to the quickness required in the operation, and the thickness of the hides and skins to be tanned; all which experience will soon teach. As all kinds of tan are not equally good, it will sometimes happen that six or more filtrations will be necessary to obtain a lixivium of 6° or 8°, in which case the number of digesters must be increased, and the same method pursued as above; and when a weaker lixivium is wanted, three or four filtrations will be sufficient.

The person directing these lixiviations should be provided with the solution of glue and sulphate of iron, already described, in order to ascertain the qualities of the different lixivia, as well as with a hydrometer properly graduated, to determine their degree of concentration or specific gravity.

In tanning cow and ox hides with this lixivium, they should first be washed in running water, well cleaned, and fleshed in the usual way. For removing the hair, the hides are to be steeped for two or three days in a vat filled with the gallic lixivium, and a mixture of sulphuric acid, marking 66° on the hydrometer for acids, and in the proportion of one to a thousand, or one pint to 125 gallons. During this steeping, the hair is separated from the hides in such a manner, that it may be easily known when they are to be taken out of the vat, that is, when the hair is quite loose. It is to be scraped off with a round knife on the horse or beam.

When raising is necessary, the hides are immersed for 10 or 12 hours in a vat filled with water, and $\frac{1}{100}$ of its volume of mineral acid, of the same quality with the former, and the operation of raising is finished. The hides are repeatedly washed, and the round knife is used, after which they are prepared for tanning.

The rest of the process consists in tanning, properly so called; for which purpose, the hides are to be steeped some hours in a weak lixivium of only 1° or 2°; to obtain which, that is to be taken which runs from the second digester, or some already used for tanning. They are next put into a stronger lixivium, where in a few days they will be brought to the same degree of saturation with the liquor in which they are immersed. The strength of the liquor being then much diminished, it must be renewed; and when the hides are completely saturated, or fully tanned, which is known by cutting off a bit of the edge, remove the leather, and let it dry slowly in a shady place.

For calf skins, goat skins, &c. these are first fleshed with the knife, and worked in running water like the others. They are then steeped in lime water, in which there should be more lime than the water can dissolve at once. What is not dissolved will subside, but must be mixed with the water, by stirring it several times a-day. In two or three days the skins are to be removed; when the hair is found quite loose, it is scraped off on the horse. They are then washed and pressed well, till the water running from them is perfectly clear, and the lime totally extracted. They are first steeped in a weak lixivium, then tanned as above; but the tanning lixivium must not be nearly so strong as that for hides.

Lime is used for these soft skins instead of a mixture of gallic lixivium and sulphuric acid, because the acid always swells the leather more or less, and because the lime may be more easily extracted from them, by washing and compressing them, than from the thick hides, which, when limed, are harsh and apt to crack, if the lime be not wholly extracted before they are tanned.

Among the different methods of immersion which may be practised in the course of these operations, the best way seems to be that of suspending the hides and skins vertically in the lixivia, by means of transverse rods or bars, and at such a distance asunder as not to touch each other in any one point. If they are laid out the one over the other, they will require frequent *handling*, in order that all the parts may be equally saturated, and to prevent the folds or plaits that would otherwise be formed in them. In some cases it will be found expedient to mix fresh tan from time to time with the lixivium, which will depend on the state and quality of the hides and skins to be tanned, as well as on the purposes for which they are intended. All these considerations must be left to the judgment of the manufacturer; but they do not change the principle on which this mode of tanning is founded.

Mr Desmond asserts, that besides the very great savings in point of time and labour, the leather tanned according to the above method being more completely saturated, will be found to weigh heavier, to wear better, and to be less susceptible of moisture, than the leather tanned in the usual way*.

* Philos. Mag. xi. 20.

7 Principles of tanning.

In explaining the principles on which the several parts of the tanning process depend, we must first remark, that the principal object of tanning is, to combine

Tanning. bine the gelatinous part of the hides with the tanning principle of astringent vegetables as intimately as possible, and thus produce that compound which we call leather, and which is insoluble in water. The chief part of the process therefore consists in steeping the hides in a solution of tannin till they are sufficiently impregnated with the tanning principle; and to this operation the others are subservient, only as they prepare the hides to be more easily acted on by the tanning principle.

The infusions of oak bark, when chemically examined, are found to contain two principal substances, one precipitable by solution of gelatine made from glue or isinglass, and this gives a dense black, with solution of common sulphate of iron; the other not precipitable by solution of gelatine, but precipitating the salts of iron of a brownish black, and the salts of tin of a fawn colour.

The former of these is the tanning principle, or the tannin of Seguin; it is essential to the conversion of skin into leather. The latter is the colouring or extractive matter; it is capable of entering into union with skin, and it gives to it a brown colour; but it does not render it insoluble in boiling water.

It has been generally supposed that the infusion of oak bark contains a peculiar acid, called gallic acid; but some late experiments render this opinion doubtful; and this principle, if it exists in oak bark, is in intimate combination with the extractive or colouring matter.

In the common process of tanning, the skin, which is chiefly composed of gelatine, slowly combines in its organized form with the tannin and extractive matter of the infusions of bark; the greater proportion of its increase of weight, however, is owing to tannin, and from this substance the leather derives its characteristic properties; but its colour, and the degree of its flexibility, appear to be influenced by the quantity of colouring matter that it contains. When skin, in large quantity, is suffered to exert its full action on a small portion of infusion of bark, containing tannin and extractive matter, the fluid is found colourless. It gives no precipitate to solution of gelatine, and produces very little effect on the salts of iron or of tin. The tanning principle of oak bark is more soluble in water than the extractive matter; and the relative proportion of tannin to extractive matter is much greater in strong infusions of oak bark than in weak ones; and when strong infusions are used for tanning, a larger proportion of tannin is combined with the matter of skin.

The state of the skin with regard to its impregnation with tannin may be easily ascertained by cutting it transversely with a sharp knife, as the tanned part will appear of a nutmeg colour, while the unimpregnated part retains its whiteness. Though the impregnation of the skins with tannin be an essential part of the process, something more is required to give the leather its proper degree of strength and pliability. The infusions of oak bark, especially the weaker infusions, contain, besides tannin, more or less of extractive matter, which is absorbed by the skins during the tanning process. Hence it appears, that a solution of tannin alone would not convert the skins into leather; and that as concentrated infusions of oak bark contain a less proportional quantity of extractive matter, they are not so well calculated for the purposes of tanning as the weaker infusions. This is an important conclusion, as it shews that the vulgar opinion of tanners respecting the propriety of the old methods, and what they call *feeding* the leather, is founded on rational principles. In fact it appears, that, though, in the quick method, recommended by Seguin and Desmond, the leather may be more expeditiously, and perhaps more completely impregnated with tannin, it is deficient in strength and pliability, from the want of its due proportion of extractive matter.

Having thus explained the principles on which the material part of the tanning process depends, we must briefly notice the *rationale* of the preliminary operations.

Chaptal has shewn, that when skin is immersed in a tanning liquor, without having been previously freed from its cuticle or scarf-skin, the impregnation of tannin takes place only on the flesh side. This shews the necessity, especially in the thicker hides or butts, of removing the cuticle, before steeping the hides in the tanning liquor. The small degree of putrefaction to which the butts are subjected, has this effect, and the steeping of the hides and skins in lime water contributes to the same end; for though lime does not seem to be capable of dissolving the cuticle, it renders it friable, so that it is easily removed by the instruments employed for scraping off the hair. Not only the cuticle, but likewise the soft matter of the extremity of the hair is acted on by lime; and this effect must considerably tend to facilitate the process of depilation. The same substance mixing with the fat on the fleshy side of the skins, forms a soapy compound, which, with other extraneous matter, is removed by the subsequent washings.

It has been supposed that the acids in which the skins are steeped, previous to their immersion in tanning liquors, have the effect of opening their pores, and thus rendering them more easily penetrable by the tanning principle and extractive matter. We believe that this opinion is erroneous, as we cannot see how acids, the obvious effect of which seems to be that of contracting animal matter, can enlarge the pores of the skins. It is probable that they produce some other advantageous effect not yet sufficiently understood, in preparing the skins for being more perfectly acted on by the tanning liquors.

The principal effect of the grainer, or the pigeons dung employed in the thinner skins, seems to be that of promoting putrefaction, and rendering the skins less elastic, though the alkali evolved during the fermentation of the dung, may assist in removing the fat on the flesh side of the skins.

Substitutes for oak bark. As from the present great demand, and consequent scarcity of oak timber, oak bark has become a very expensive article, it may be proper to enumerate a few of the principal vegetable substances, especially those indigenous to Great Britain, that may be substituted for it. Of these the bark of the Scotch fir appears to be most deserving of attention, and was some years ago employed by a gentleman in Ireland with great success. Several species of willow afford a good substitute for oak bark, particularly the Leicester willow, of which the entire bark produces a greater quantity of solid extract than the entire bark of oak. Next to these may be mentioned the bark of the common elm, the root of tormentil (*tormentilla vulgaris*, Lin.) which has been long employed in the north of Scotland as an article of domestic

mestic tanning. To these may be added the herb avens (*geum urbanum*, Lin.), several species of cinquefoil, and of bistort, common ladies mantle (*alchemilla vulgaris*), and the root of the common water-flag (*iris pseudacorus*, Lin.). Of plants not indigenous to Britain, but generally cultivated here, we may particularly notice the *horse-chesnut*, the bark of which is a strong astringent, and might be employed, we think, with great advantage in tanning. The most powerful tanning substance, however, with which we are acquainted, is the juice or extract of the *mimosa catechu*, commonly called *Japan earth*, one pound of which will tan as much leather as seven or eight pounds of oak bark.

Our limits will not permit us to extend this article, by describing the processes for tanning employed in other countries. On the method pursued in Russia, our readers may consult Tooke's *View of the Russian Empire;* and of the French method of tanning, an ample account has been given in a publication by De Lalande. Another on the same subject may soon be expected from Chaptal. The most complete work on British tanning, and on other processes to which leather is subjected, with which we are acquainted, is a small volume entitled *The Art of Tanning and Currying Leather*, published by the Dublin Society in 1780. Several useful papers on this subject may also be found in Nicholson's *Philosophical Journal*, and Tilloch's *Philosophical Magazine.*

For an account of other processes connected with the leather manufacture, see LEATHER and CURRYING.

TANTALIUM, a new metal which has been detected in two minerals. See MINERALOGY, p. 250.

TANTALUS, in fabulous history, king of Phrygia and Paphlagonia, was the son of Jupiter and the nymph Plota. He one day entertained the gods at his table; when, to prove their divinity, he served up his son Pelops cut in pieces. All the deities, except Ceres, perceived his cruelty and impiety, and would not touch his provisions. That goddess, whose thoughts were solely employed about her daughter Proserpine, inadvertently ate a part of his left shoulder. Pelops, however, was restored to life; and an ivory shoulder given him in the room of that which had been eaten; while Tantalus was thrown into Tartarus, where he was punished with perpetual hunger and thirst. He was chained in a lake; the water of which reached up to his chin, but retired when he attempted to drink. The branch of a tree loaded with fruit hung down even to his lips, but on his attempting to pluck the fruit the branch sprung upwards.

TANTALUS, a genus of birds belonging to the order of grallæ. See ORNITHOLOGY *Index*.

TANTALUS's Cup. See *SCIENCE, Amusements of*, N° 33.

TANZY, or TANSY. See TANACETUM, BOTANY *Index*.

TAORMINA, a town in Sicily, which is situated on a high rock, and is 88 miles south of Messina. Of its origin little is known. A colony from the isle of Naxos settled at the foot of Etna, at no great distance from the shore, and at about a league or a league and a half from the present situation of Taormina. Dionysius the Tyrant attacked this colony, and either took or set fire to their city. The inhabitants retired to the rocks of Mount Taurus; among which they found a tract of

ground sufficiently level and secure, and of sufficient extent. Here therefore they built a city; which, after the mountain, they named *Tauromenium*. It was at length raised to a very flourishing state by trade, and became celebrated as a seat of the arts, the remains of which show that the fine arts must have been once successfully cultivated at Tauromenium.

Among other remains are still to be seen a spacious theatre, a tomb, and a long natural grotto, which appears to have been anciently adorned within with artificial ornaments. After the inhabitants of Taormina embraced Christianity, they still continued to visit this grotto with devout veneration. Instead of the Pagan divinities to whom it had before been sacred, they substituted a saint, the venerable St Leonard. But St Leonard did not long draw crowds to this grotto; and the Christians have either defaced its Pagan decorations, or suffered them to fall into decay by the injuries of time. It is now black and smoky; and it is with difficulty that any remains of the Greek paintings with which it was once ornamented can be distinguished.

TAPE-WORM. See TÆNIA, HELMINTHOLOGY *Index*.

TAPER, TAPERING, is understood of a piece of timber, or the like, when thick at one end, and gradually diminishing to the other; as is the case in pyramids, cones, &c.

To measure TAPER-Timber, &c. See *SLIDING Rule.*

TAPER-Bored, is applied to a piece of ordnance when it is wider at the mouth than towards the breech.

TAPER, also denotes a kind of tall wax candle, placed in a candlestick, and burnt at funeral processions, and in other church solemnities.

Tapers are made of different sizes; in some places, as Italy, &c. they are cylindrical; but in most other countries, as England, France, &c. they are conical or taper; whence possibly the name; unless we rather choose to derive taper, in the adjective sense from the substantive taper, in the Saxon *tapen* or *tapon*, *cereus*, "wax-candle." Both kinds are pierced at bottom for a pin in the candlestick to enter.—There are two ways of making tapers, the first with the ladle, the second by hand; for which see CANDLE.

Paschal TAPER, among the Romanists, is a large taper, whereon the deacon applies five bits of frankincense, in holes made for the purpose in form of a cross; and which he lights with new fire in the ceremony of Easter Saturday.

The Pontifical makes Pope Zosimus the author of this usage; but Baronius will have it more ancient, and quotes a hymn of Prudentius to prove it. That pope he supposes to have only established the use thereof in parish-churches, which, till then, had been restrained to greater churches.

F. Papebroch explains the original of the paschal taper more distinctly, in his *Conatus Chronico-Historicus*, &c. It seems, though the council of Nice regulated the day whereon Easter was to be celebrated, it laid it on the patriarch of Alexandria to make a yearly canon thereof, and to send it to the pope. As all the other moveable feasts were to be regulated by that of Easter, a catalogue of them was made every year; and this was written on a taper, *cereus*, which was blessed in the church with much solemnity.

Taper, Tapestry.

This taper, according to the abbot Chastelain, was not a wax-candle made to be burnt; it had no wick, nor was it any thing more than a kind of column of wax, made on purpose to write the list of moveable feasts on; and which would suffice to hold that list for the space of a year.

For among the ancients, when any thing was to be written to last for ever, they engraved it on marble or steel; when it was to last a long while, they wrote it on Egyptian paper; and when it was only to last a short time, they contented themselves to write it on wax. In process of time they came to write the moveable feasts on paper, but they still fastened it to the paschal taper. Such is the original of the benediction of the paschal taper.

TAPESTRY, a kind of cloth made of wool and silk, adorned with figures of different animals, &c. and formerly used for lining the walls of rooms, churches, &c.

The art of weaving tapestry is supposed to have been borrowed from the Saracens; accordingly the workmen employed in this manufacture in France were formerly called *Sarazins* or *Sarazinois*. Guicciardini ascribes the invention of tapestry hangings to the inhabitants of the Netherlands; but he has not mentioned at what time the discovery was made. This art was brought into England by William Sheldon, near the end of Henry VIII.'s reign. In 1619 a manufacture was established at Mortlake in Surry by Sir Francis Crane, who received 2000l. from King James to encourage the design. The first manufacture of tapestry at Paris was set up under Henry IV. in 1606 or 1607, by several artists whom that monarch invited from Flanders. Under Louis XIV. the manufacture of the Gobelins was instituted, which has introduced very beautiful cloths, remarkable for strength, for elegance of design, and a happy choice of colours. The finest paintings are copied, and eminent painters have been employed in making designs for the work.

Tapestry-work is distinguished by the workmen into two kinds, viz. that of high and that of low warp; though the difference is rather in the manner of working than in the work itself; which is in effect the same in both: only the looms, and consequently the warps, are differently situated; those of the low warp being placed flat and parallel to the horizon, and those of the high warp erected perpendicularly. The English anciently excelled all the world in the tapestry of the high warp; and they still retain their former reputation, though with some little change: their low warps are still admired; but as for the high ones, they are quite laid aside by the French. The French, before the revolution, had three considerable tapestry manufactures besides that of the Gobelins; the first at Aubusson in Auvergne, the second at Felletin in the Upper Marche, and the third at Beauvais. They were all equally established for the high and the low warp; but they had all laid aside the high warp excepting the Gobelins. There were admirable low warps likewise in Flanders, generally exceeding those of France; the chief and almost only Flemish manufactures were at Brussels, Antwerp, Oudenard, Lisle, Tournay, Bruges, and Valenciennes; but of the state of these manufactures now we are ignorant.

The usual widths of tapestry are from two ells to three ells Paris measure.

The Manufacture of Tapestry of the High Warp.—The loom on which it is wrought is placed perpendicularly: it consists of four principal pieces; two long planks or cheeks of wood, and two thick rollers or beams. The planks are set upright, and the beams across them, one at the top and the other at the bottom, or about a foot distance from the ground. They have each their trunnions, by which they are suspended on the planks, and are turned with bars. In each roller is a groove, from one end to the other, capable of containing a long round piece of wood, fastened therein with hooks. The use of it is to tie the ends of the warp to. The warp, which is a kind of worsted, or twisted woollen thread, is wound on the upper roller; and the work, as fast as wove, is wound on the lower. Withinside the planks, which are seven or eight feet high, fourteen or fifteen inches broad, and three or four thick, are holes pierced from top to bottom, in which are put thick pieces of iron, with hooks at one end serving to sustain the coat-stave: these pieces of iron have also holes pierced, by putting a pin in which the stave is drawn nearer or set farther off; and thus the coats or threads are stretched or loosened at pleasure. The coat-stave is about three inches diameter, and runs all the length of the loom; on this are fixed the coats or threads, which make the threads of the warp cross each other. It has much the same effect here as the spring stave and treddles have in the common looms. The coats are little threads fastened to each thread of the warp with a kind of sliding knot, which forms a sort of mesh or ring. They serve to keep the warp open for the passage of broaches wound with silks, woollens, or other matters used in the piece of tapestry. In the last place, there are a number of little sticks of different lengths, but all about an inch in diameter, which the workman keeps by him in baskets, to serve to make the threads of the warp cross each other, by passing them across; and, that the threads thus crossed may retain their proper situation, a packthread is run among the threads above the stick.

The loom being thus formed, and mounted with its warp, the first thing the workman does is to draw on the threads of this warp the principal lines and strokes of the design to be represented on the piece of tapestry; which is done by applying cartoons made from the painting he intends to copy to the side that is to be the wrong side of the piece, and then, with a black lead pencil, following and tracing out the contours thereof on the thread of the right side; so that the strokes appear equally both before and behind.

As for the original design the work is to be finished by, it is hung up behind the workmen, and wound on a long staff, from which a piece is unrolled from time to time as the work proceeds.

Besides the loom, &c. here described, there are three other principal instruments required for working the silk or the wool of the woof within the threads of the warp; these are a broach, a reed, and an iron needle. The broach is made of a hard wood, seven or eight inches long, and two-thirds of an inch thick, ending in a point with a little handle. This serves as a shuttle; the silks, woollens, gold, or silver, to be used in the work

work being wound on it. The reed or comb is also of wood, eight or nine inches long, and an inch thick on the back, whence it grows less and less to the extremity of the teeth, which are more or less apart, according to the greater or less degree of fineness of the intended work. Lastly, the needle is made in form of the common needle, only bigger and longer. Its use is to press close the wool and silks when there is any line or colour that does not fit well.

All things being prepared for the work, and the workman ready to begin, he places himself on the wrong side of the piece, with his back towards the design: so that he works as it were blindfold, seeing nothing of what he does, and being obliged to quit his post, and go to the other side of the loom whenever he would view and examine the piece, to correct it with his pressing-needle. To put silk, &c. in the warp, he first turns and looks at the design; then, taking a broach full of the proper colour, he places it among the threads of the warp, which he brings cross each other with his fingers, by means of the coats or threads fastened to the staff; this he repeats every time he is to change his colour. Having placed the silk or wool, he beats it with his reed or comb; and when he has thus wrought in several rows over each other, he goes to see the effects they have, in order to reform the contours with his needle, if there be occasion. As the work advances, it is rolled upon the lower beam, and they unroll as much warp from the upper beam as suffices them to continue the piece: the like they do of the design behind them. When the pieces are wide, several workmen may be employed at once.

We have but two things to add: the first is, that the high warp tapestry goes on much more slowly than the low warp, and takes up almost twice the time and trouble. The second is, that all the difference that the eye can perceive between the two kinds, consists in this, that in the low warp there is a red fillet, about one-twelfth of an inch broad, running on each side from top to bottom, which is wanting in the high warp.

Manufacture of Tapestry of the Low Warp.—The loom or frame, whereon the low warp is wrought, is much like that of the weavers; the principal parts thereof are two strong pieces of wood forming the sides of the loom, and bearing a beam or roller at each end: they are sustained at bottom with other strong pieces of wood in manner of trestles; and, to keep them the firmer, they are likewise fastened to the floor with a kind of buttresses, which prevent any shaking, though there are sometimes four or five workmen leaning on the fore-beam at once.

The rollers have each their trunnions, by which they are sustained: they are turned by large iron pins three feet long. Along each beam runs a groove, wherein is placed the wich, a piece of wood of about two inches diameter, and almost of the length of the roller: this piece fills the groove entirely, and is fastened therein, from space to space, by wooden pins. To the two wiches are fastened the two extremities of the warp, which is wound on the farther roller, and the work, as it advances, on the nearer.

Across the two sides, almost in the middle of the loom, passes a wooden bar, which sustains little pieces of wood, not unlike the beam of a balance: to these pieces are fastened strings, which bear certain spring staves, wherewith the workman, by means of two treddles under the loom whereon he sets his feet, gives a motion to the coats, and makes the threads of the warp rise and fall alternately. Each loom has more or fewer of these spring-staves, and each staff more or fewer coats, as the tapestry consists of more or fewer threads.

The design or painting the tapestry-man is to follow is placed underneath the warp; where it is sustained from space to space with strings, by means of which the design is brought nearer the warp.

The loom being mounted, there are two instruments used in working it, viz. the reed and the flute. The flute does the office of the weaver's shuttle; it is made of an hard polished wood, three or four lines thick at the ends, and somewhat more in the middle, and three or four inches long. On it are wound the silks or other matters to be used as the woof of the tapestry. The comb or reed is of wood or ivory; it has usually teeth on both sides; it is about an inch thick in the middle, but diminishes each way to the extremity of the teeth: it serves to beat the threads of the woof close to each other, as fast as the workman has passed and placed them with his flute amongst the threads of the warp.

The workman is seated on a bench before the loom, with his breast against the beam, only a cushion or pillow between them; and, in this posture, separating, with his fingers, the threads of the warp, that he may see the design underneath, and taking a flute, mounted with a proper colour, he passes it among the threads, after having raised or lowered them, by means of the treddles moving the spring-staves and coats.

Lastly, to press and close the threads of the silk or yarn, &c. thus placed, he strikes each course (i. e. what the flute leaves in its passing and coming back again) with the reed.

TAPIOCA, a species of starch, which the Brazileans make from the roots of the cassada plant. See JATROPHA, BOTANY *Index*.

TAPIR, a quadruped of the order of belluæ, resembling the hippopotamus. See MAMMALIA *Index*.

TAPPING, in general, the act of piercing a hole in a vessel, and applying a tube or canula in the aperture, for the commodious drawing off the liquor contained therein.

TAPPING, in *Surgery*. See PARACENTESIS, SURGERY *Index*.

TAPROBANA, the ancient name of the island of Ceylon. See CEYLON, and GEOGRAPHY, N° 28.

TAR, a thick, black, unctuous substance, obtained chiefly from old pines and fir-trees by burning them with a close smothering heat. It is prepared in great quantities in Norway, Sweden, Germany, Russia, and North America, and in other countries where the pine and fir abound.

Becher the celebrated chemist, first proposed to make tar from pit-coal. Manufactures for this purpose have been established many years ago in the bishopric of Liege, and in several parts of England. In the year 1781, the earl of Dundonald obtained a patent for extracting tar from pit-coal by a new process of distillation. Great hopes were entertained of the value of this discovery, but we have not heard that it has answered expectation.

Tar, which is well known for its economical uses, is properly an empyreumatic oil of turpentine, and has been much used as a medicine both internally and externally. Tar-water, or water impregnated with the more soluble parts of tar, was formerly a very popular remedy.

TARANTO, the ancient TARENTUM, a sea-port town of Italy, in the kingdom of Naples, and in the Terra de Otranto. It is a strong and populous place, with an archbishop's see, and the title of a principality. It is seated on a peninsula, and is defended by a strong castle; but the harbour is choked up. E. Long. 17. 29. N. Lat. 40. 35.

TARANTULA, a species of aranea, so called from Taranto, the place where it is said to abound. See ARANEA, ENTOMOLOGY *Index*.

TARASCON, an ancient and populous town of France, in the department of the Mouths of the Rhone, and late province of Provence, with a well-built castle, seated on the river Rhone, opposite Beaucaire, with which it communicates by a bridge of boats. Its commerce consists in oil, brandy, starch, and stuffs that are much worn, one sort being of coarse silk, and the other of the same material and wool. It is 10 miles north of Arles, and 375 south by east of Paris. E. Long. 4. 45. N. Lat. 43. 46.

TARAZONA, a strong town of Spain, in the kingdom of Arragon, and on the frontiers of Old Castile, with a bishop's see. It is seated partly on a rock, and partly in a fertile plain, on the river Chiles. It was taken from the Moors in 1110. W. Long. 1. 26. N. Lat. 42. 10.

TARCHONANTHUS, FLEA-BANE, a genus of plants belonging to the class syngenesia; and in the natural system ranging under the 49th order, *Compositæ*. See BOTANY *Index*.

TARE, is an allowance for the outside package that contains such goods as cannot be unpacked without detriment; or for the papers, threads, bands, &c. that inclose or bind any goods imported loose; or though imported in casks; chests, &c. yet cannot be unpacked and weighed neat.

TARE, or VETCH. See VICIA, BOTANY *Index*.

TARGET, a kind of shield or weapon of defence made use of by the ancients.

TARGIONIA, a genus of plants belonging to the class of cryptogamia, and natural order of *Algæ*. See BOTANY *Index*.

TARGUM, a name given to the Chaldee paraphrases of the books of the Old Testament. They are called *paraphrases* or *expositions*, because they are rather comments and explications than literal translations of the text. They are written in the Chaldee tongue, which became familiar to the Jews after the time of their captivity in Babylon, and was more known to them than the Hebrew itself. So that when the Hebrew text was read in the synagogue, or in the temple, they generally added to it an explication in the Chaldee tongue for the service of the people, who had but a very imperfect knowledge of the Hebrew tongue. It is probable, that even from the time of Ezra this custom began, since this learned scribe, reading the law to the people in the temple, explained it with the other priests that were with him, to make it understood by the people (Nehem. viii. 7—9.).

But though the custom of making these sorts of expositions in the Chaldee language be very ancient among the Hebrews, yet have they no written paraphrases or targums before the era of Onkelos and Jonathan, who lived about the time of our Saviour. Jonathan is placed about 30 years before Christ, under the reign of Herod the Great. Onkelos is something more modern. The Targum of Onkelos is the most of all esteemed, and copies are to be found in which it is inserted verse for verse with the Hebrew. It is so short and so simple, that it cannot be suspected of being corrupted. This paraphrast wrote only upon the books of Moses; and his style approaches nearly to the purity of the Chaldee, as it is found in Daniel and Ezra. This targum is quoted in the Misna, but was not known either to Eusebius, St Jerome, or Origen.

The Targum of Jonathan son of Uziel is upon the greater and lesser prophets. He is much more diffuse than Onkelos, and especially upon the lesser prophets, where he takes great liberties, and runs on in allegories. His style is pure enough, and approaches pretty near to the Chaldee of Onkelos. It is thought that the Jewish doctors who lived above 700 years after him made some additions to him.

The Targum of Joseph the Blind is upon the Hagiographa. This author is much more modern, and less esteemed than those we have now mentioned. He has written upon the Psalms, Job, the Proverbs, the Canticles, Ecclesiastes, Ruth, and Esther. His style is a very corrupt Chaldee, with a great mixture of words from foreign languages.

The Targum of Jerusalem is only upon the Pentateuch; nor is that entire or perfect. There are whole verses wanting, others transposed, others mutilated; which has made many of opinion that this only is a fragment of some ancient paraphrase than is now lost. There is no targum upon Daniel, or upon the books of Ezra and Nehemiah.

These targums are of great use for the better understanding not only of the Old Testament, on which they are written, but also of the New. As to the Old Testament, they serve to vindicate the genuineness of the present Hebrew text, by proving it to be the same that was in use when these targums were made, contrary to the opinion of those who think the Jews corrupted it after our Saviour's time. They help to explain many words and phrases in the Hebrew original, and they hand down to us many of the ancient customs of the Jews. And some of them, with the phraseologies, idioms, and peculiar forms of speech, which we find in them, do in many instances help as much for the better illustration and better understanding of the New Testament as of the Old; the Jerusalem Chaldee dialect, in which they are written, being the vulgar language of the Jews in our Saviour's time. They also very much serve the Christian cause against the Jews, by interpreting many of the prophecies of the Messiah in the Old Testament in the same manner as the Christians do. Many instances are produced to this purpose by Dr Prideaux in his *Connect. of the Hist.* of the Old and New Testament, vol. iv. p. 777, &c.

These targums are published in the second edition of the great Hebrew Bible set forth at Basil by Buxtorf the father, anno 1610; for he has rectified the Chaldee text, and reformed the vowel pointings in it; the targums having at first been written without vowel points, which were afterwards added very erroneously by some Jews.

Tarif || Tartary.

TARIF, a table containing the names of different sorts of merchandise, with the duties to be paid as settled among trading nations.

TARPA, Spurius Mecius, a Latin critic in the time of Julius Cæsar and Augustus. He had his tribunal in the temple of Apollo, where, with four assistants, he passed sentence on the works of the poets. Cicero and Horace make honourable mention of this critic.

TARPAULIN, a piece of canvas, well tarred over, to keep off the rain from any place. The term is also often applied in a burlesque sense to a person that has been all his life bred to the sea.

TARPEIAN, in Roman antiquity, an appellation given to a steep rock in Rome; whence, by the law of the twelve tables, those guilty of certain crimes were precipitated. It took its name from Tarpeia, a vestal virgin, who was killed by the Sabines, as related under the article Rome, N° 24.

TARQUIN the Elder, king of Rome, succeeded Ancus Martius 615 B. C. See Rome, N° 35—40.

Tarquin the *Proud*, a tyrant and usurper. See Rome, N° 49—51, &c.

TARRAGON, or Dragon-wort. See Botany *Index*.

TARROCK, a species of lorus. See Ornithology *Index*.

TARSHISH, a town frequently mentioned by ancient authors, the situation of which it is difficult to ascertain. See Ophir.

TARTAN, in sea language, a small coasting vessel navigated in the Mediterranean, with only one mast and a bowsprit, the principal sail, which is very large, being extended by a lateen-yard. When tartans put up a square sail, it is called a *sail of fortune*.

TARTAR, a hard solid substance which separates from wine after complete fermentation, and adheres to the top and sides of the casks. It is an impure tartrate of potash with the acid in excess. See Chemistry, N° 999.

TARTARIC acid. See Chemistry, p. 529.

1 Divisions.

TARTARY, a name given by geographers and historians to a considerable extent of territory in Asia, lying between Russia and China, and including a great variety of nations, now chiefly dependent on these two empires. The whole country is usually divided into *Western Tartary*, and *Eastern* or *Chinese Tartary*, of which the former includes Western Turkistan, Kharism, and Great Bucharia; while the latter comprehends the country of the *Monguls* and the *Mandshurs*, now both subject to Russia, and Little Bucharia. The geography of several parts of this extensive tract has already been considered under the articles Bucharia, China, and Russia, and we shall here confine ourselves to that which is now commonly known by the name of *Independent Tartary*, by which we understand that extent of country now possessed by the *Kirghises*, and the Usbeck Tartars, including the Kharism, and Great and Little Bucharia.

2 Extent, &c. of Independent Tartary.

Independent Tartary thus defined, extends from the Caspian sea on the west to the mountains of Belur on the east, a space of about 870 British miles, and from the mountains of Gaur in the south, to the southern boundaries of the Russian empire on the north, including nearly 1500 British miles. About half of this extent is occupied by the Kirghises to the north, and the Usbecks to the south.

Tartary.

3 Kirghises.

The country of the Kirghises is separated from Siberia by the great steppe or desert of Issim, an extensive plain intersected by a river of the same name, and abounding with lakes of salt and bitter waters. Even the soil of this steppe is in many places impregnated with salt and nitre, though in several spots the soil is by no means unfruitful. There are no towns, as the inhabitants dwell wholly in tents.

The Kirghises have been long divided into three principal hordes, called the *great*, *middle*, and *lesser*. Of these, the two latter are now regarded as subjects of the Russian empire, though they seem by no means to be dependent on that power. The great horde, defended by mountains on the south and east, are properly independent. This last horde is supposed to contain about 60,000 families, while the lesser and middle hordes are said to comprehend each about half that number. The whole population is computed at about 500,000.

The Kirghises have gradually moved from the east towards the west. Their manners are described at considerable length by Pallas. Their tents are of a sort of felt; their drink kumiss, made of acidulated mares milk. The great horde is considered as the source of the other two. Being settled near the mountains of Alak, or *Ala Tau*, this horde has been called the Alatanian Kirghises. They lead a wandering life, from the borders of the Upper Sirr, near Tashkund, to the steppe of Issim. Each horde has its particular khan; but the middle horde, when Pallas visited this country, was contented with a prince, who seemed to acknowledge the khan of the lesser horde; and in 1777, this khan was called Nur Hali, an equitable prince. Their features are Tartaric, with flat nose and small eyes, but not oblique like those of the Monguls and Chinese. They have horses, camels, cattle, sheep, and goats. Some individuals of the middle horde, it is said, had 10,000 horses, 300 camels, 4000 cattle, 20,000 sheep, and upwards of 2000 goats; while in the lesser horde were proprietors of 5000 horses, and a proportional number of the other animals. Their dromedaries furnish a considerable quantity of woolly hair, sold to the Russians and Bucharians, being annually clipped like that of sheep. Their chief food is mutton; and the lamb is so exquisite, that it is sent from Orenburg to St Petersburg for the tables of the palace. The lamb skins are the most celebrated next to those of Bucharia; but the wool of the sheep is coarse, and used only for domestic purposes, for felts and thick cloths. The steppes supply them with objects of the chase, wolves, foxes, marmots, antelopes, &c. In the southern and eastern mountains are found wild sheep, the ox of Tibet, which seems to delight in snowy alps; with chacals, tigers, and wild asses.

As the Kirghisians regard each other as brethren, they are obliged to employ slaves who are captives taken in their incursions. Their dress consists of close vests, large trowsers, and pointed boots. The ladies adorn their heads with the necks of herons, disposed like horns. They appear to be Mahometans, but have a more relaxed creed.

The Kirghisians carry on some trade with Russia. The chief traffic is at Orenburg, and wholly by exchange; but the middle horde proceed to Omsk. About 150,000 sheep are annually brought to Orenburg, with horses, cattle, lamb skins, camels wool, and sometimes slaves.

Tartary. slaves. In return they take manufactured articles, chiefly clothes and furniture. From Bucharia, Khiva, and Tashkund, they receive arms and coats-of-mail, which Russia refuses, in return for camels and cattle. They are extremely fond of the Kalmuk women, who long retain their charms; and often marry them if they will adopt the Mahometan religion. They have an annual festival in honour of the dead. About the beginning of the 17th century this people, who were formerly Shamanians, became children of circumcision, by the exertions of the priests of Turkistan.

4 Usbeks. The country of the Usbek Tartars includes Kharism and part of Great Bucharia. The former of these extends from the river Gihon to the Caspian sea, and is bounded on the north and east by vast deserts. Its length is about 400 British miles, and its breadth rather less than 350. The chief town is Khiva, besides which there are five walled cities or towns, within half a day's journey of each other. The khan is absolute, and independent of any but the high priest, or lama, by whom he is controlled. The Kievinski Tartars differ little from the Kirghises, but surpass even them in treachery. Their manners are nearly the same, except that the Kirghises live in tents, while the others inhabit cities and villages. Their only trade is with Bokhara and Persia; whither they carry cattle, furs, and hides, which they procure from the Kirghises and Turkoman Tartars. The place itself produces little more than cotton, lamb furs, of a bad quality, and some raw silk; part of

5 Town of Khiva. which they manufacture. The town of Khiva stands on a rising ground, with three gates, and a strong thick wall of earth much higher than the houses, with turrets at small distances, and a broad deep ditch full of water. It occupies a large space, and commands a pleasant prospect; but the houses are built with mud, having flat roofs covered with earth. It is 17 days journey from the Caspian sea, and 33 from Orenburg, allowing 40 versts to the day's journey.

The people of Khiva bring to Orenburg large quantities of raw cotton; but the coasts of the Caspian are held by some remains of Turkomans in the north, and by Usbeks in the south. A considerable trade is carried on with Mangushlak. As the merchants of Khiva brought gold and gems to Astrakan, probably from the two Bucharias, it was suggested to Peter the Great that these products were found in Kharism, in consequence of which he attempted a settlement. But the Russians, to the number of 3000, were cut off by the Usbeks.

6 Great Bucharia. Great Bucharia, by far the most important part of Independent Tartary, extends for about 700 British miles in length from north to south, by a medial breadth of about 350, being bounded on the north by the mountains of Argun, and divided from Kharism and Corazan by the river Amu, and extensive deserts, while on the south and east it has for its boundaries the mountains of Gaur and of Beber.

The chief city of Great Bucharia is SAMARCAND, on the southern bank of the river Sogd. The other places of note are BOKHARA on the same river, Balk on the river Dehash, Zouf, and Kotlan.

The face of the country presents a great variety, abounding with rivers, hills, and mountains, but being in general deficient in wood. Near the rivers the soil is very productive, the grass sometimes exceeding the height of a man; and in some parts much industry is shown in the cultivation of rice and other grain.

The rivers are, the Amu and Sirr. Besides the sea of Aral, already described under that head, there are several considerable lakes, particularly that of Palkati, Tengis, or Balcash, being about 140 miles long by 70 broad.

"In all the regions of the earth (says Sir William Ouseley), there is not a more flourishing or a more delightful country than this, especially the district of Bokhara. If a person stand on the Kohendis (or ancient castle) of Bokhara, and cast his eyes around, he shall not see any thing but beautiful and luxuriant verdure on every side of the country; so that he would imagine the green of the earth and the azure of the heavens were united; and as there are green fields in every quarter, so there are villas interspersed among the green fields. The Sogd, for eight days journey, is all delightful country, affording fine prospects, and full of gardens and orchards, and villages, corn fields, and villas, running streams, reservoirs, and fountains, both on the right hand and on the left. You pass from corn fields into rich meadows and pasture lands; and the straits of Sogd are the finest in the world." 7 Religion of the Tartars.

The religion of the Usbeks and Bucharians is the Mahometan of the Sunni sect, and the government of the khans is despotic. There are no accounts to be met with of the state of the population, but it is believed that on any emergency they could muster an army of 100,000. The revenue of these fertile provinces is not certainly known, though that of Corasan is said to amount to half a million sterling annually, and it is probable that the revenue of Great Bucharia is at least equal to that of Corasan. 8 Trade.

Besides the caravans to Persia, Hindostan, and China, some trade is carried on with the Russians; the Bucharian merchants not only furnishing their own products, but others from the eastern countries to which they trade. 9 Manners.

The manners and customs of the Usbeks are similar to those of the other Tartars; but they are supposed to be the most spirited and industrious of these barbarians. Though many reside in tents in the summer, yet in winter they inhabit the towns and villages. They are accustomed to make sudden inroads into the Persian provinces. The native Bucharians are comparatively fair, and correspond in form and features with those of Little Bucharia. The Bucharians never bear arms. The Usbeks, on the contrary, are no strangers to the use of the musket, and it is said that even their women are not averse to warfare. The language is Turkish, but that of the Bucharians has never been investigated, though it be probably a dialect of the Persian. Their literature would furnish an ample theme, Samarcand having been a celebrated school of oriental science, cultivated even by monarchs, as Ulug Beg and others.

"Such are the generosity and liberality of the inhabitants, that no one (says Sir William Ouseley), turns aside from the rites of hospitality; so that a person contemplating them in this light, would imagine *that all the families of the land were but one house*. When a traveller arrives there, every person endeavours to attract him to himself, that he may have opportunities of performing kind offices for the stranger; and the best proof of their hospitable and generous disposition is that every

every peasant, though possessing but a bare sufficiency, allots a portion of his cottage for the reception of a guest. On the arrival of a stranger they contend one with another for the pleasure of taking him to their home, and entertaining him. Thus, in acts of hospitality, they exceed their incomes. I happened once to be in Sogd, and there I saw a certain palace, or great building, the doors of which were fastened back with nails against the walls. I asked the reason of this, and they informed me that it was a hundred years and more since those doors had been shut, all that time they had continued open day and night; strangers might arrive there at the most unseasonable hours, or in any numbers, for the master of the house had provided every thing necessary both for the men and for their beasts; and he appeared with a delighted and joyful countenance when the guests tarried a while."

For a more particular account of the manners and customs of the Tartars, see the articles BUKHARIA and KALMUKS; Pallas's *Travels in the Southern Provinces of the Russian Empire*, and Tooke's *View of the Russian Empire*. An account of the Baschkirs, also a tribe of wandering Tartars, and of the Tartars of the Krimea, has been given under RUSSIA.

We cannot here enter on the history of Tartary. The most interesting parts of it will be found under the articles CHINA and MOGUL, and we may refer those who wish for a more detailed account to the 4th volume of the *Modern Universal History*, and to the *Asiatic Researches*.

Krim TARTARY. See CRIMEA.

TARTRATES, in *Chemistry*, are saline bodies, composed of an alkaline, earthy, or metallic base, and tartaric acid.

TASSEL, a pendant ornament at the corners of a cushion, &c. In building, tassels denote those pieces of board that lie under the ends of the mantlet trees.

TASSO, TORQUATO, celebrated Italian poet, was born at Sorrento in the kingdom of Naples, in 1544. He was the son of Bernardo Tasso, and of Portia de Rossi, a lady of an illustrious family of Naples.

At three years of age Tasso was committed by his father to the care of Angeluzza, a man of great learning, who at this tender age, it is said, began to teach him grammar; at four he was sent to the Jesuits college, and at seven he was well acquainted with Latin and Greek. At the age of 12 he went from Rome to Mantua, where his father had entered into the service of the duke Guglielmo Gonzaga; he had then completed his knowledge of the Latin and Greek languages; he was well acquainted with rhetoric and poetry, and master of Aristotle's Ethics. He was soon after sent to the university of Padua; and at 18, published his Rinaldo, a poem on the plan of Homer's Odyssey. This extended his fame through all Italy; but his father went to Padua, to remonstrate against his apparent purpose of giving himself up to philosophy and poetry, and made use of many harsh expressions, which Tasso heard with great patience. "Of what use is that philosophy on which you value yourself so much?" "It has enabled me (replied Tasso) to endure the harshness of your reproofs."

He soon after went to Bologna, by the invitation of the city and college; but in a short time he returned to Padua at the urgent desire of Scipio Gonzaga, who had been elected prince of the academy established in that city under the name of the *Ætherei*. In this retreat he formed the design of his *Jerusalem Delivered*, invented the fable, disposed the parts, and determined to dedicate it to the house of Este; and being pressed to reside at Ferrara, he gave his consent. The duke of Ferrara gave him an apartment in his palace, where he lived in peace and affluence, and prosecuted his work, which he determined to dedicate to the duke, and which was published book by book, as he finished them.

At the age of 30 he finished his *Jerusalem*, and the whole was reprinted and published together, the success of which was astonishing. It was translated into Latin, French, Spanish, and even the oriental languages, almost as soon as it appeared. Soon after the publication of his *Jerusalem* he lost his father, who had been appointed governor of Ostia on the Po by the duke of Mantua; and a pretended friend to Tasso, belonging to Ferrara, to whom he had incautiously committed some transactions of a very delicate nature concerning his patron the duke, had the perfidy to betray him. This coming to the ears of the duke, he shut up Tasso in prison, from which, however, he found means to escape, after a year's confinement, and retired to Turin, being then about 34 years of age, and was recommended to the duke of Savoy, who shewed him many marks of esteem and regard. Fearing, however, that he might be delivered up to the duke of Mantua, he secretly retired to Rome, and went directly to his friend Mauritio Cataneo, by whom he was received with great kindness, and his presence made the whole city rejoice. Here he endeavoured to make his peace with the duke, and was fortunate enough to succeed.

After this he lived at Mantua about a year, in great favour with the prince; but growing weary of a state of dependence, he resolved to go to Naples, and endeavour to recover his mother's jointure, which had been seized by her relations; but as this law suit had no appearance of being soon determined, he went from Naples to Rome, where he continued about a year, in high favour with Pope Sextus Quintus, and then went to Florence, at the earnest desire of Ferdinando, grand duke of Tuscany, who had been cardinal at Rome when Tasso first resided there.

Having spent another year at Florence, he returned to Naples, where he corrected his Jerusalem Delivered.

Cardinal Cynthio, who was a great patron of learning and genius, and knew Tasso when he first resided at Rome, prevailed with him once more to leave his retreat at Naples and live with him in that city, where he continued till he was 50, and then returned to Naples to prosecute his law suit, from which place, however, he was soon recalled; and being introduced to the pope, his holiness said, "that his merit would confer as much honour on the laurel he was about to receive, as the laurel had formerly conferred on others."

It happened that while they waited for fair weather, for the purpose of celebrating the solemnity of Tasso's coronation with laurel, that great poet took his last illness, and died on the 15th day of his sickness, aged 51. His poems have acquired him an immortal reputation, the chief of which are, 1. Jerusalem Delivered. 2. Jerusalem Conquered. 3. Rinaldo. 4. The Seven Days of the Creation. 5. The Tragedy of Torimond.

6.

Tasso, Taste.

6. Aminta, &c. All his works were printed together at Florence in 1724, in 6 vols. folio, with the pieces for and against his Jerusalem Delivered.

TASTE, a certain sensation excited in the mind by certain bodies, which are called *sapid*, applied to the tongue and palate, and moistened with saliva. This is the original and proper meaning of the word *taste* (see METAPHYSICS, N° 46.); but as the qualities of bodies which produce these sensations are unknown, they have got the names of the sensations themselves, by substituting the cause for the effect. Tastes have been divided into simple and compound, and philosophers have endeavoured to ascertain the number of each species. Attempts have likewise been made to determine from their tastes the effects of different substances on the human body, taken into the stomach as food or physic; but by stating the results of such inquiries, we should be more likely to mislead than to communicate useful information.

TASTE is likewise used in a figurative sense, to denote that faculty by which we perceive whatever is beautiful or sublime in the works of nature or of art. This faculty relishes some things, is disgusted with others, and to many is indifferent. It has also been called an internal *sense*, and by one philosopher, a *reflex sense*, while others have considered it as the joint exertion of perception and judgment in some cases, and as a play of the imagination in others.

To decide among these different opinions, it will be necessary to ascertain, if we can, what are the objects of this faculty. *Scarlet*, *blue*, *green*, and *yellow*, are all beautiful colours, and a *cube* and a *sphere* are beautiful figures; but it does not appear to us, that a man could be said to have either a good or a bad taste for relishing the perception of a *scarlet* more than that of a *yellow* colour, or a *spherical* more than a *cubical* figure.

With respect to the objects of the external sense, we are so constituted by nature as to relish those kinds of food which are most wholesome, and such a taste is justly said to be sound and uncorrupted. It is in the highest perfection too at first, for it depends not on culture of any kind, and is incapable of improvement. The reverse is the case with respect to internal taste. Every voice, it is true, unites in applauding elegance, simplicity, spirit in writing, and in blaming affectation, or a false brilliancy; but when critics come to particulars, this seeming unanimity vanishes. Perhaps no man ever beheld the rising or setting sun without feeling emotions of pleasure; yet it is certain that the emotions of the clown are not the same, at least in degree, with those of the philosopher. Any beautiful object presented to the eye, gives a pleasing sensation to the mind; and it appears to us that the clown feels nothing more than a mere sensation from the view of the rising sun, similar to what he would feel from a blazing heath. In poetry and painting the vulgar are always delighted with the melody of the verse, and the brilliancy of the colours, and think of nothing else as beauties.

If this be so, the pleasures which the vulgar derive from what are called objects of taste, are mere gratifications of the senses; but very different is the pleasure which the man of cultivated taste derives from the beauties of nature or of art. The mere sensation of the clown is followed by a train of ideas which hurries him beyond the object before him to its beneficent effects and its Almighty Creator.

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The nature of any person's taste, therefore, is generally determined from the character of his imagination and the soundness of his judgment. The simple perception of the object we find is insufficient to excite these emotions, unless it is accompanied with this operation of mind. Thus, when we feel the beauty or sublimity of natural scenery, we are conscious of a variety of images in our minds very different from those which the objects themselves can present to the eye.

If the mind is in such a state as to prevent this freedom of imagination, the emotion is not perceived. In so far as the beauties of nature or art affect the external senses, their effect is the same on every man who is in possession of these senses. But to a man in pain or in grief, the same scene will not produce any feeling of admiration, which at other times would have produced it in perfection.

There are many objects of taste which produce not their full effect on the imagination, but through the medium of the judgment. The beauty of the Farnese Hercules is one kind of beauty; that of the gladiators in the palace of Chighi, another; and that of the Apollo Belvidere a third. Each of these figures is acknowledged to be perfect in its kind; but according to Sir Joshua Reynolds, the highest perfection of the human figure is not to be found but in that form which might be taken from them all, and which would partake of the activity of the gladiator, of the delicacy of the Apollo, and of the muscular strength of the Hercules. In this view the perfection of these statues consists in something which being perceived by the eye, is referred by the understanding to what we know of the characters of Hercules, Apollo, and the gladiator, and which we suppose it was the intention of the statuaries to express. There are besides, objects of which taste is sometimes said to judge, though they have little or no effect whatever on the imagination. A book of abstract science, written in a prolix and intricate style, may be said to be in a bad taste; and had Swift, in his clear and simple style, written an *Essay on the Human Understanding*, his work, supposing him master of the subject, would undoubtedly have displayed more taste than Locke's in which the terms are sometimes vague, and the period often encumbered. This is the case of Berkeley, who is admitted by all to have been a writer of good taste, though neither the Principles of Human Knowledge, the Dialogues on Matter, nor the Minute Philosopher, is capable of affording pleasure, either to the senses or the imagination. His beauty consists merely in the perspicuity of his style, of which the understanding alone is the judge. The metaphysical writings of Dr Reid possess in an eminent degree the same beauty; and no man of true taste can read them without admiring the elegant simplicity of the composition as much as the strength of the reasoning, and feeling from the whole a pleasure which the poetical style of Shaftesbury cannot communicate.

If this be a just account of the pleasures of taste, that faculty cannot be properly considered as a mere internal sense, since to its enjoyments a well-stored fancy is necessary in some cases, and the reasoning power in all; and the poet and the painter who wished to excel in their

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their respective professions, must not content themselves, the one with filling the ear of the reader with mellifluous sounds, and the other with dazzling or deceiving the eye of the spectator by the brilliancy of his colours, but both must strive for fame by captivating the imagination; whilst the architect, who aspires to a similar celebrity, must make the purpose of his ornaments obvious to every person capable of judging. The landscapes of Claude Lorrain, the music of Handel, and poetry of Milton, excite feeble emotions in our minds, when our attention is confined to the qualities they present to our senses, or when it is to such qualities of their composition that we turn our regard. It is then only we feel the sublimity or beauty of their productions, when our imaginations are kindled by their power, when we lose ourselves amid the number of images that pass before our minds, and when we waken at last from this play of fancy as from the charm of a romantic dream.

It is well observed by Sir Joshua Reynolds *, that taste is sometimes praised in such terms by orators and poets, who call it *inspiration*, and *a gift from heaven*, that though a student by such praise may have his attention roused, and a desire excited of obtaining this gift, he is more likely to be deterred than encouraged in the pursuit of his object. "He examines his own mind, and perceives *there* nothing of that divine inspiration with which he is told so many others have been favoured. He never travelled to heaven to gather new ideas; and he finds himself possessed of no other qualifications than what mere common observation and a plain understanding are able to confer. Thus he becomes gloomy amidst the splendour of figurative declamation, and thinks it hopeless to pursue an object which he supposes out of the reach of human industry. But on this, as on many other occasions, we ought to distinguish how much is to be given to enthusiasm, and how much to common sense; taking care not to lose in terms of vague admiration that solidity and truth of principle upon which alone we can reason." Whoever possesses the ordinary powers of perception, sensibility of heart, good sense, and an imagination capable of being roused by the striking objects of nature and of art, may, without inspiration, become, by mere experience, a man of fine taste in the objects of which he aspires to be a critical judge.

* *Discourse delivered at the Royal Academy*, Dec. 14. 1770.

This being the case, we may easily account for the variety of tastes which prevail among man, not only as individuals but as nations. We have already mentioned the difference in one instance between the European taste and the African respecting female beauty; and we may now affirm, as we hope to prove our affirmation, that the one taste is equally correct with the other. The charms of female beauty exist not in the mere external form and colour considered by themselves (for then the inanimate statue of the Venus de Medicis would give more delight to the European beholder than the finest woman that ever lived); but we associate external beauty with sweetness of disposition, and with all the train of endearments which take place in the union of the sexes; and it is this association which delights the man of taste, as giving refinement to an appetite which itself is gross and sensual. A similar association must be formed in the breast of the African who has any taste; and as he never knew feminine softness, or any of the endearing qualities of the sex, but as united with thick lips, a flat nose, a black skin, and woolly hair—a sable beauty of that description must excite in his breast the same emotions that are excited in the breast of an European by the fair woman with Grecian features.

But is there not an ideal or perfect beauty of the human form? There certainly is, as of every other natural object; but it cannot be the same in Europe as in Africa, unless to a Being who is acquainted with all the peculiarities of form, national and individual, that are to be found among the inhabitants of the whole earth. It has been supposed, and we think completely proved, by one of the best writers that we have on the philosophy of taste *, that the sublimity or beauty of forms arises altogether from the associations we connect with them, or the qualities of which they are expressive to us. The qualities expressed by the male and female forms are very different; and we would by no means think the woman beautiful who should have the form of the Farnese Hercules, or admire the shapes of the hero who should be formed like the Venus de Medicis; because the proportions of such a woman would indicate strength and intrepidity, where we wish to find only gentleness and delicacy; and the delicate form of the hero would indicate softness and effeminacy, where the opposite qualities only can be esteemed. As we associate with the female form many desirable qualities, every woman is esteemed more or less beautiful as her figure and features indicate a greater or smaller number of these qualities; and the same is the case with respect to the qualities which adorn the male character, and the form and features by which they are expressed. Upon comparing a number of human beings with one another, we find, that with respect to every feature and limb, there is one central form to which nature always tends, though she be continually deviating from it on the right hand and on the left: (See NOSE). This form therefore is considered as the most perfect form of the species, and most expressive of the qualities for which that species is valued; but in Africa, the central form, with respect to the proportions of the human body and the features of the human face, is very different from what it is in Europe; and therefore the ideal or perfect beauty of the human form and features cannot be the same in both countries. No doubt, if a man could examine the limbs and features of every individual of the human race, he would discover one central form belonging to the whole, and be led to esteem it the standard of beauty; but as this is obviously impossible, the common idea or central form belonging to each great class of mankind must be esteemed the standard of beauty in that class, as indicating most completely the qualities for which individuals are esteemed. Thus there is a common form in childhood and a common form in age; each of which is the more perfect as it is the more remote from peculiarities: but though age and childhood have something in common, we should not deem the child beautiful who was formed exactly like the most handsome man, nor the man handsome who was formed exactly like the most beautiful child. This doctrine is well illustrated by Sir Joshua Reynolds, who has applied it to every object esteemed beautiful in nature; and proved, that the superiority of Claude Lorrain over the landscape-painters of the Dutch and Flemish

* *Mr Alison.*

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Flemish schools, arise chiefly from his having generalized his conceptions, and formed his pictures by compounding together the various draughts which he had previously made from various beautiful scenes and prospects. "On the whole (says he), it seems to me that there is but one presiding principle which regulates and gives stability to every art. The works, whether of poets, painters, moralists, or historians, which are built upon general nature, live for ever; while those which depend for their existence on particular customs and habits, a particular view of nature, or the fluctuation of fashion, can only be coeval with that which first raised them from obscurity. All the individual objects which are exhibited to our view by nature, upon close examination, will be found to have their blemishes and defects. The most beautiful forms have something about them like weakness, minuteness, or imperfection. But it is not every eye that perceives these blemishes: It must be an eye long used to the contemplation and comparison of these forms; which alone can discern what any set of objects of the same kind has in common, and what each wants in particular."

From these reasonings the same great artist concludes, that the man who is ambitious of the character of possessing a correct taste, ought to acquire a "habit of comparing and digesting his notions. He ought not to be wholly unacquainted with that part of philosophy which gives him an insight into human nature, and relates to the manners, characters, passions, and affections. He ought to know *something* concerning *mind*, as well as a great deal concerning the *body*, and the various external works of nature and of art; for it is only the power of distinguishing right from wrong that is properly denominated *taste*.

"Genius and taste, in the common acceptation, appear to be very nearly related; the difference lies only in this, that genius has superadded to it a habit or power of execution. Or we may say, that taste, when this power is added, changes its name, and is called *genius*. They both, in the popular opinion, pretend to an entire exemption from the restraint of rules. It is supposed that their powers are intuitive; that under the name of *genius* great works are produced, and under the name of *taste* an exact judgment is given, without our knowing why, and without being under the least obligation to reason, precept, or experience.

"One can scarce state these opinions without exposing their absurdity; yet they are constantly in the mouths of men, and particularly of illiterate and affected connoisseurs. The natural appetite, or taste of the human mind, is for *truth;* whether that truth results from the real agreement or equality of original ideas among themselves, from the agreement of the representation of any object with the thing represented, or from the correspondence of the several parts of any arrangement with each other It is the very same taste which relishes a demonstration in geometry, that is pleased with the resemblance of a picture to an original, and touched with the harmony of music.

"But besides *real*, there is also *apparent* truth, or opinion, or prejudice. With regard to real truth, when it is known, the taste which conforms to it is and must be uniform. With regard to the second sort of truth, which may be called *truth upon sufferance*, or *truth by courtesy*, it is not fixed but variable. However, whilst these opinions and prejudices on which it is founded continue, they operate as truth; and the art, whose office it is to please the mind as well as instruct it, must direct itself according to *opinion*, or it will not attain its end. In proportion as these prejudices are known to be generally diffused or long received, the taste which conforms to them approaches nearer to certainty, and to a sort of resemblance to real science, even where opinions are found to be no better than prejudices. And since they deserve, on account of their duration and extent, to be considered as really true, they become capable of no small degree of stability and determination by their permanent and uniform nature.

"Of the judgment which we make on the works of art, and the preference that we give to one class of art over another, if a reason be demanded, the question is perhaps evaded by answering, I judge from my taste; but it does not follow that a better answer cannot be given, though for common gazers this may be sufficient. Every man is not obliged to investigate the causes of his approbation or dislike. The arts would lie open for ever to caprice and casualty, if those who are to judge of their excellencies had no settled principles by which they are to regulate their decisions, and the merit or defect of performances were to be determined by unguided fancy. And indeed we may venture to assert, that whatever speculative knowledge is necessary to the artist, is equally and indispensably necessary to the critic and the connoisseur.

"The first idea that occurs in the consideration of what is fixed in art or in taste, is that presiding principle which we have already mentioned, the general idea of nature. The beginning, the middle, and the end of every thing that is valuable in taste, is comprised in the knowledge of what is truly nature; for whatever ideas are not conformable to those of nature or universal opinion, must be considered as more or less capricious; the idea of nature comprehending not only the forms which nature produces, but also the nature and internal fabric and organization, as I may call it, of the human mind and imagination. General ideas, beauty, or nature, are but different ways of expressing the same thing, whether we apply these terms to statues, poetry, or picture. Deformity is not nature, but an accidental deviation from her accustomed practice. This general idea therefore ought to be called *nature:* and nothing else, correctly speaking, has a right to that name. Hence it plainly appears, that as a work is conducted under the influence of general ideas, or partial, it is principally to be considered as the effect of a good or a bad taste."

Upon the whole, we may conclude that the real substance, as it may be called, of what goes under the name of *taste*, is fixed and established in the nature of things; that there are certain and regular causes by which the imagination and passions of men are affected; and that the knowledge of these causes is acquired by a laborious and diligent investigation of nature, and by the same slow progress as wisdom or knowledge of every kind, however instantaneous its operations may appear when thus acquired. A man of real taste is always a man of judgment in other respects; and those inventions which either disdain or shrink from reason, are generally more like the dreams of a distempered brain than the exalted enthusiasm of a sound and true genius. In the midst of the highest flights of fancy or imagination, reason ought to to preside from first to last; and he who shall decide on the beauties of any one of the fine arts by an imaginary innate sense or feeling, will make as ridiculous an appearance as the connoisseur mentioned by Dr Moore, who praised as a work of the divine Raphael the wretched daubing by a Swiss copyist. The reader who wishes for further instruction in the philosophy of taste, may consult Gerard's Essay on Taste, with the dissertations of Voltaire, D'Alembert, and Montesquieu; Alison's Essays on the Nature and Principles of Taste; and Sir Joshua Reynold's Discourses delivered in the Royal Academy. See also the article BEAUTY, SUPPLEMENT.

TATE, NAHUM, an English poet, born in Ireland about the middle of the reign of Charles II. where he received his education. He was made poet-laureat to King William upon the death of Shadwell, and held that place until the reign of George I. whose first birth-day ode he lived to write, and executed it with unusual spirit. He died in the Mint in 1716. He was the author of nine dramatic performances, a great number of poems, and a version of the Psalms in conjunction with Dr Brady.

TATIAN, a writer of the primitive church in the second century. He was born in Assyria, and trained up in the heathen religion and learning. Coming over to Christianity, he became the disciple of Justin Martyr, whom he attended to Rome. While Justin lived, he continued steadily orthodox: but after Justin's death he made a schism, and became the author of a new sect, condemning marriage, enjoining abstinence from wine and animal food, and suffering only water to be used in the holy mysteries; whence his followers were called *Encratitæ* and *Hydroparastatæ*. None of his works are now extant, but his piece against the Gentiles; or, as it is usually entitled, his *Oration to the Greeks*.

TATIUS, ACHILLES, a native of Alexandria, was the author of a book on the sphere, which Father Petau translated into Latin. There is also attributed to him a Greek romance on the loves of Leucippe and Clitophon, of which Salmasius has given a beautiful edition in Greek and Latin with notes. Suidas says, that this Achilles Tatius was a Pagan, but that he afterwards embraced the Christian religion, and became a bishop. Photius mentions him in his Bibliotheca.

TATONNEUR. See LEMUR, MAMMALIA *Index*.

TATTOOING, or TATTOWING, an operation in use among the islanders in the South sea for marking their bodies with figures of various kinds which they consider as ornamental. It is performed by puncturing the skin, and rubbing a black colour into the wounds. The instrument used somewhat resembles a comb, the teeth of which are repeatedly struck into the skin by means of a small mallet. It is very painful; but the children are forced by their relations to submit to it.

TATTOU, a beat of a drum at night to advertise the soldiers to retreat, or repair to their quarters in the garrison, or to their tents in a camp.

TAVERNIER, JOHN BAPTIST, a French traveller, was born in 1605. In the course of 40 years he travelled six times to Turkey, Persia, and the East Indies, and visited all the countries in Europe, travelling mostly on foot. His travels have been frequently reprinted in six volumes 12mo. He died on his seventh journey to the east, at Moscow, in 1686.

TAVIRA, or TAVILA, a considerable town of Portugal, and capital of the province of Algarve, with a handsome castle, and one of the best harbours in the kingdom, defended by a fort. It is seated in a fertile country, at the mouth of the river Gilaon, between Cape Vincent and the strait of Gibraltar, 100 miles west-by-north of Cadiz. W. Long. 7. 46. N. Lat. 37. 18.

TAVISTOCK, a town of Devonshire in England, situated on the river Tavey or Tave, containing 4723 inhabitants in 1811. W. Long. 4. 12. N. Lat. 50. 37. It sends two members to parliament, and gives the title of *marquis* to the noble family of Russel duke of Bedford.

TAUNTON, a large, elegant, and well built town of Somersetshire, 146 miles from London. It consists principally of four streets paved and lighted; the market-place is spacious, and has a handsome market-house, with a town hall over it, which was finished in 1773. It has an extensive woollen manufactory; and in 1780 a silk manufactory was introduced. Its castle, the ruins of which remain, was in 1645 defended for the parliament by Colonel Blake against an army of 10,000 men under Lord Goring, but was dismantled by Charles II. In 1685 the duke of Monmouth made this place his head-quarters. Its church, which is large and beautiful, is a fine specimen of the florid Gothic style of architecture. The tower, which is lofty, is of excellent workmanship, crowned at the top with four stately pinnacles, 32 feet high. The whole perhaps is not equalled in the kingdom. Taunton is pleasantly seated on the river Tone, which is navigable to Bridgewater; is reckoned the best town in the county; sends two members to parliament; and contained 6997 inhabitants in 1811. W. Long. 3. 17. N. Lat. 50. 59.

TAURIS, or TEBRIS, a town of Persia, and capital of Aderbeitzan. It was formerly the capital of Persia, and is now the most considerable next to Ispahan; for it contains 15,000 houses, besides many separate shops, and about 200,000 inhabitants. It is about five miles in circumference, and carries on a prodigious trade in cotton, cloth, silks, gold and silver brocades, fine turbans, and shagreen leather. There are 300 caravanseras, and 250 mosques. Some travellers suppose it to be the ancient Ecbatana; but of this there is no certainty. It is seated in a delightful plain, surrounded with mountains, from whence a stream issues, which runs through the city. E. Long. 47. 50. N. Lat. 38. 18.

TAURUS, a great chain of mountains in Asia, which begin at the eastern part of Little Carimania, and extend very far into India. In different places they have different names.

TAURUS, in *Astronomy*, one of the 12 signs of the zodiac.

TAUTOLOGY, a needless repeating of the same thing in different words.

TAWING, the art of dressing skins in white, so as to be fit for divers manufactures, particularly gloves, &c.

All skins may be tawed; but those chiefly used for this purpose are lamb, sheep, kid, and goat skins.

The method of tawing is this: Having cleared the skins of wool or hair by means of lime, they are laid in a large vatt of wood or stone, set on the ground, full of water, in which quicklime has been slaked; wherein they are allowed to lie a month or six weeks according as the weather is more or less hot, or as the skins are required to be more or less soft and pliant.

While they are in the vatt, the water and lime are changed twice, and the skins are taken out and put in again every day: and when they are taken out for the last time, they are laid all night to soak in a running water, to get out the greatest part of the lime; and in the morning are laid together by sixes one upon another, upon a wooden leg, and are scraped stoutly one after another, to get the flesh off from the fleshy side, with a cutting two-handled instrument called a *knife*; and then they cut off the legs (if they are not cut off before) and other superfluous parts about the extremes. Then they are laid in a vatt or pit with a little water, where they are fulled with wooden pestles for the space of a quarter of an hour; and then the vatt is filled up with water, and they are rinsed in it.

In the next place, they are thrown on a clean pavement to drain, and afterwards cast into a fresh pit of water, out of which they rinse them well, and are laid again on the wooden leg, six at a time, with the hair side outermost: after which they rub a kind of whetstone very briskly, to soften and fit them to receive four or five more preparations, given them on the leg both on the flesh side and the hair-side, with the knife, after the manner above mentioned.

After this they are put into a pit of water and wheaten bran, and stirred about in it with wooden poles, till the bran is perceived to stick to them, and then they are left: as they rise of themselves to the top of the water by a kind of fermentation, they are plunged down again to the bottom; and at the same time fire is set to the liquor, which burns as easily as if it were brandy, but goes out the moment the skins are all covered.

They repeat this operation as often as the skins rise above the water; and when they have done rising they take them out, lay them on the wooden leg, the fleshy side outwards, and pass the knife over them to scrape off the bran.

Having thus cleared them of the bran, they lay the skins in a large basket, and load them with huge stones to promote the draining: and when they have drained sufficiently, they give them their feeding; which is performed after the manner following:

For 100 of large sheep skins, and for smaller in proportion, they take eight pounds of alum and three of sea-salt, and melt the whole with water in a vessel over the fire, pouring the solution out, while yet lukewarm, into a kind of trough, in which is twenty pounds of the finest wheat-flour, with the yolks of eight dozen of eggs; of all which is formed a kind of paste, a little thicker than children's pap; which, when done, is put into another vessel, to be used in the following manner.

They pour a quantity of hot water into the trough in which the paste was prepared, mixing two spoonfuls of the paste with it; to do which they use a wooden spoon, which contains just as much as is required for a dozen of skins: and when the whole is well diluted, two dozen of the skins are plunged into it; but they take care that the water be not too hot, which would spoil the paste and burn the skins.

After they have lain some time in the trough they take them out, one after another, with the hand, and stretch them out; this they do twice: and after they have given them all their paste, they put them into tubs, and there full them afresh with wooden pestles.

They then put them into a vatt, where they are suffered to lie for five or six days, or more; then they take them out in fair weather, and hang them to dry on cords or racks: and the quicker they are dried the better; for if they be too long a drying, the salt and alum within them are apt to make them rise in a grain, which is an essential fault in this kind of dressing.

When the skins are dry, they are made up into bundles, and just dipt in fair water, and taken out and drained: they are then thrown into an empty tub; and after having lain some time are taken out and trampled under foot.

They then draw them over a flat iron instrument, the top of which is round like a battledore, and the bottom fixed into a wooden block, to stretch and open them; and having been opened, they are hung in the air upon cords to dry; and being dry, they are opened a second time, by passing them again over the same instrument.

In the last place, they are laid on a table, pulled out, and laid smooth, and are then fit for sale.

TAXATION. Besides those expences which are necessary to the existence, or conducive to the comfort and enjoyment of private individuals, there are others of which the benefit is directly applicable to the whole society. These benefits indeed are chiefly of a negative kind, but they are not therefore the less essential. They consist in the preservation of person and property from that violence both internal and external, to which the irregular passions of human nature continually expose them. The regular administration of justice, and defence against foreign enemies, are so essential to the well-being of a people, that they can with no propriety hesitate, when necessary, to part even with a large portion of their income in order to provide for the proper accomplishment of these objects. A certain pomp and magnificence too, in those who are to take the lead in these departments, have been deemed both ornamental to the society, and necessary for securing respect and obedience from the body of the people. If, besides these grand and indispensable advantages of foreign and internal security, public funds can be applied to any other purposes, evidently tending to promote the national well-being, yet beyond the reach of private exertions,—to canals, high roads, or public institutions of any description,—there can be no doubt surely as to the propriety of such an application.

It is evident, therefore, that the money which is necessary for the above purposes, forms a perfectly necessary and proper part of national expenditure. The government of the country, indeed may, as elsewhere observed (POLITICAL ECONOMY), economically speaking, be considered as part of its fixed capital, essential to the advantageous employment of the rest. Without the security which the labourer thence derives, of reaping the fruits of his industry, he would have little motive to action; every thing would be the prey of the strongest, and

and all impulse to activity ceasing, universal poverty would ensue. At the same time we may observe with regard to this as to other fixed capitals, that the expence is expedient only so far as it is necessary, and that if the same functions can be performed at a smaller cost, a decided gain arises to the public. It becomes therefore an important object to inquire in what manner the offices of government may be adequately performed, with the least burden on the people.

We have formerly, under the head of POLITICAL ECONOMY, slightly illustrated some leading principles respecting public revenue. But as the subject is important, we shall consider it here in somewhat greater detail.

Taxes may be arranged in the following manner. 1. *Assessed taxes*, or those which the subject is required to pay directly into the hands of the sovereign or commonwealth. Under this title are comprehended all the taxes which bear the above name; all income or capitation taxes, and every species of land taxes. These taxes are almost always intended to fall upon income. 2. Taxes upon commodities, which are paid, in the first instance, not by the consumer, but by the producer, or importer. These taxes fall upon consumption; the man who does not use the articles, pays no tax. They operate thus partly as sources of revenue, and partly as sumptuary laws. 3. *Stamp duties*, or duties upon those deeds which regulate the transference of property. These duties fall chiefly upon capital.

1. *Assessed Taxes.*—Assessed taxes, according to the above definition, seem to be the most simple and direct mode of raising a revenue. The money comes at once from the pockets of the people into those of the sovereign. No tax is so certain of yielding a revenue. The money is demanded, and must be paid. Where properly arranged also, they may probably be made to fall more equally than any other, upon the different classes, according to their ability. In absolute governments, therefore, and in governments little skilled in the science of finance, these taxes are commonly preferred, as those which can be levied with the least trouble. They have likewise this merit that they cost little in the collection, and consequently nearly their whole amount is brought into the treasury.

Assessed taxes, however, are liable to many objections. None are so heavily felt. In other cases the tax is concealed under the price of the commodity with which it confounds itself; but here the money is paid directly without any thing in return. It must generally too be paid in a considerable sum at once, a circumstance which must often be productive of serious inconvenience, while the same sum, broken down into small portions, might have been paid without difficulty. For these reasons, much greater discontent is excited by these taxes than by taxes upon commodities. A double revenue perhaps, may, in the latter way, be raised with less murmuring. In popular governments, therefore, and in those where finance has been reduced to a system, the object has generally been to avoid direct assessment as much as possible. In this country, the greater part, by far, of the revenue had been raised by taxes upon commodities, till, within these last twenty years, the pressure of public wants made it necessary to have recourse to every mode of raising money which promised to be effectual, and thus the assessed taxes have been raised to a very great amount. The most important of these taxes may be included under *land tax*, *capitation taxes*, *house tax*, and *income tax*.

Land Tax.—There is no class of men who may with more propriety be burthened with an extraordinary imposition, than the proprietors of land. They enjoy commonly a liberal income, without care or trouble of their own. Their property, being of permanent value, is much preferable to any source of income which expires with its possessor. From being local and immoveable, it is peculiarly dependent on the protecting influence of government, and may therefore be reasonably called upon to contribute something more than the common share to its support. In almost all countries, therefore, the landholders, besides being liable to the same burdens with the rest of the society, are subject to a peculiar tax, called *land tax*.

In India and other great oriental empires, the principal revenue of the sovereign is derived from land. It arises, however, not properly in the way of tax, but of rent. The sovereign, in those absolute governments, is judged to be the sole proprietor of all the land in his dominions, which are let out by him or his deputy, to the farmers. This is also the principal source of the revenue which we derive from our East Indian possessions. It is otherwise, however, in all the European countries. There, almost all the land is private property, and the contribution which government draws from it is therefore a tax.

The adherents of the economical system have proposed to substitute a land tax in the room of every other. They maintain that all taxes must finally fall upon the produce of land, since it alone affords that surplus revenue, out of which public contributions can be drawn. Were this doctrine true, much trouble and expence would doubtless be saved, exchanging the present complicated and laborious system of taxation, for one so simple and easy. But we have already endeavoured to show, under the head of POLITICAL ECONOMY, that the principles of this sect have no solid foundation; that manufactures and commerce are sources of wealth, as well as agriculture, though in a somewhat inferior degree. It will follow, therefore, that they are equally liable to be affected by taxation. It is in vain to urge that the merchant must have his profit, and the labourer his hire, and that otherwise they will not employ their capital and labour. Were a tax to be imposed upon any one branch of industry, leaving the rest untouched, there is no doubt, that wages and profit in that branch must rise, till the merchant or labourer is placed on a level with the rest of the community, otherwise he will transfer his capital and industry to some other branch. But where the imposition falls indiscriminately upon the different employments of labour and stock, there is no such refuge; the labourer and merchant must suffer a diminution of income; nor is there any process by which he can throw this diminution upon the landlord.

Other persons of a much less informed character, are often heard urging, that we have only to lay the imposition upon the landlords; and that they will not be long of indemnifying themselves by raising the rent of their lands. Such arguments will make little impression upon those who have at all attended to the true principles of political economy. The value of lands, as of every other article, is determined by the demand and the

the supply. A tax upon the rent of land would have no tendency, either to increase the one, or to diminish the other, consequently no tendency to raise the value of land. Indeed, were we to suppose, according to this hypothesis, that proprietors have an unlimited power of raising their lands, whenever they are so inclined, it is quite contrary to common sense to suppose that they should not exert that power, without waiting for the stimulus of a tax.

For these reasons, land cannot, with any propriety, be made the sole subject of taxation; but it is very fair, as above observed, that it should pay somewhat more than other sources of revenue. A difficulty, however, arises from the variations to which its value is subject, sometimes on the decreasing, but more commonly on the increasing side. The rate which, at one time, is equitable, becomes quite otherwise at another. An attempt, on the part of government, to keep up a continual survey of all the lands in the kingdom, would be attended with a very heavy expence, and would, after all, be probably fruitless. Besides, such a measure would operate as a discouragement to the improvement of land, when so large a share would go out of the hands of the improver. These objections have weighed so strongly with the legislature of this country, that they have not raised this tax, since its first imposition in the reign of King William. It was then meant to be at the rate of four shillings in the pound, though in fact, it was by no means so much. It was also very unequally distributed, even at the beginning; a serious evil, which, however, it might have required very great trouble to avoid. Since that time, a great and general rise has taken place in the value of land, which has made this tax much higher still, than when it was originally imposed. It has also rendered it, however, still more unequal. Although almost all the land in Great Britain has improved; yet this improvement has taken place in very different proportions, according as each district differed in natural advantages, and in the industry of the inhabitants. The land tax accordingly is, at the present moment, most exceedingly unequal; but as it fortunately happens, that there is scarcely a district in Great Britain which has not improved more or less, the general moderation of the tax has rendered its inequality less grievous.

A method has been proposed of obviating this disadvantage, by keeping a register, in which the landlord and tenant shall be jointly obliged to enter the rent which the land bears, a new entry being made at every variation. A valuation may be made of the lands which the proprietor keeps in his own possession. Something of this kind, it is said, actually takes place in the Venetian territory. The discouragement to improvement indeed still remains, but even this might be obviated by an equitable, and even liberal allowance being made, for any sums which the landlord may satisfactorily prove to have been expended in this way. The chief objection to the plan seems to be the danger of collusion between the farmer and landlord, who would have a mutual interest in representing the rent as less than it really was. The agreement indeed might, by law, be made obligatory on the farmer only to the extent of the sum registered; but it may be doubtful, whether even this regulation would always be an adequate security against fraud. The valuations would necessarily depend a good deal upon the discretion of the revenue officer; which, in an arbitrary government at least, might become a serious objection. The additional expence of such a plan would be considerable; but, provided it could be made to answer the purpose, this ought not to deter from its adoption.

Frederick of Prussia imposed a higher tax upon lands held by a noble, than upon those held by a base tenure. He conceived that the privileges and flattering advantages of nobility were such as to compensate for this additional charge. We are rather disposed to consider this proceeding as severe. A nobleman, with the same income, is poorer than a commoner, because he has a greater rank to support; and in the present state of Europe, a great proportion of the nobility are extremely poor. This extreme, however, is much better than that of France before the revolution, of the Austrian states, and of most of the old governments of Europe. There the nobility, possessing the chief influence in the administration, had obtained for themselves liberal exemptions, and thrown the principal weight of this, as of other taxes, upon the inferior orders. In Sardinia, and in some provinces of France, lands held by a noble tenure paid nothing whatever.

Some taxes upon land are proportioned, not to its rent, but to its produce. This is the case in the Asiatic countries. In China, a tenth, and in India, a fifth of the whole produce of the land, are claimed by government. In England and Ireland, the church is supported by a tax of this kind, which is called *tithe*.

These taxes are liable to two very great objections. They are, in the first place, unequal. It is rent only that can be the proper subject of taxation; that part of the produce which is necessary to pay the expence of cultivation, ought to remain untouched. But this expence is far greater in poor than in rich lands. In the former, perhaps, the produce may be little more than sufficient to pay the expences incurred; while in rich lands not only the necessity of labour is less, but the produce greater. If, by well employed capital, and costly cultivation, the farmer succeeds in extracting tolerable crops from an ungrateful soil, it is both cruel and unjust that he should be obliged to pay as much as if he had no such obstacle to struggle with.

But if this tax be objectionable on the ground of equity, it is still more so, on that of expediency. The first excitement to labour and improvements of every kind, must undoubtedly be the prospect of enjoying their fruits. Where the rate of taxation is fixed, this prospect remains unimpaired; for whatever addition the proprietor or farmer can, by such means, make to the produce of his land, is all his own. But the case is very different, when it must be so deeply shared in by persons who have done nothing to forward this increase of produce. A sovereign prince indeed may derive, from such an arrangement, some motive to encourage agriculture, and improve the means of communication, so as to raise the value of its produce. But this advantage, which will scarcely ever counterbalance the attendant evils, disappears altogether, when this imposition is to be paid for the support of an ecclesiastical body. These, being only life-renters, and seldom possessed of much capital, cannot be expected to co-operate in in any measure for the improvement of the lands. The jarrings too, which are likely to take place between the pastor and his flock, form a moral argument against this mode of support.

It must not be concealed, however, that a permanent commutation of tithes would be a measure little favourable to the interests of the clergy. It seems both just to themselves, and advantageous to the public, that when the country is in a state of improvement, this body should not be left behind; it should be able to keep pace with the other members of the society. This it can never do, if it has merely a certain fixed sum allotted for its maintenance, without the possibility of augmentation. This evil has, in fact, been seriously felt in the church of Scotland, the income of whose members, notwithstanding all that has been done for their relief, is still very inferior to what it was thirty or forty years ago. A source of income, which rises or falls with the value of land, seems the most effectual mode of maintaining this proportion between the income of the clergy, and of the rest of the society; we need not, therefore, wonder, that the clergy should be so tenacious of it.

To reconcile these contrarieties, would certainly be attended with difficulty; yet it does not seem to be absolutely impossible. The first object would be, to transfer the tax from the produce to the rent. This might be done by forming a correct estimate, on an average of a few years, of the value of the tithe; and then assigning a claim to such a proportion of the rent, as would be equal to that value. This would remove all discouragements to the exertion of the cultivator. Those which press against the exertions of the landlord would indeed remain in full force, though without any increase. In most cases, these exertions would be of very small importance, when compared with those of the former. But, besides, a scheme might probably be contrived similar to that above suggested, by which the landlord might receive an adequate allowance for any improvements he might make.

The ground-rent of houses forms part of the rent of land. In remote country situations, it is often no more than the same land would yield, if employed for the purposes of agriculture. But in the vicinity, and still more in the heart of a great town, competition, and the value attached by convenience or fashion to some particular situations, raise this rent to a very extravagant height.

Ground-rent seems to be a still more proper subject of taxation than that of common land. It arises commonly from circumstances entirely independent of any care or attention on the part of the proprietor. Yet ground rents have never been considered as a separate subject of taxation. This has probably been from the difficulty of distinguishing them from the building rent. In every tax upon houses, however, part must fall upon the ground rent, provided that be able to bear it. By diminishing the demand for houses, it will diminish also the demand for ground to build them on.

Capitation or *Poll Taxes*,—afford one of the easiest and more obvious modes of taxation. To lay an assessment upon every individual without exception, seems the most effectual mode of preventing all trouble, and leaving no room for evasion. In most of the absolute governments, where the sovereign does not claim the sole property of the lands, as in Turkey and Russia, poll taxes are imposed in lieu of land tax.

The rudest form of this imposition is, when it is laid equally upon every individual. An equality of this kind is the most grievous inequality. To make the poorest subject pay as much as the richest, is palpably unjust. The only case, where such a tax can be proper, is where it falls upon slaves. In this case, it is paid, not by the slave, but by the master. The number of slaves forms the most accurate test of the value of his property; and accordingly, in Russia, an estate is described, not by the number of acres, but by the number of slaves which it contains. This tax has also the good property of encouraging manumission. In all other cases, such a tax can only be rendered tolerable by its extreme moderation.

Nations were not long of perceiving the preposterous nature of this arrangement, and of seeking to substitute some more equitable one in its place. Fortune was evidently the most correct standard to proceed upon; but a close inquisition into private concerns was conceived to be burdensome and oppressive, If each individual were to report his own fortune, could the report be trusted to? If, on the other hand, the assessment were to be regulated by the officers of government, according to what they supposed to be his wealth, a door was opened to vexatious and arbitrary proceedings. In order to avoid these opposite dangers, it has been common to regulate the contribution according to the rank of the contributor, which it is supposed will bear at least a certain proportion to his fortune. This was the case with the different poll taxes imposed in this country during the reign of King William. It was the case also in France with regard to that part of the *taille* which fell upon the nobility. It is extremely unequal; for many men of rank have no fortune corresponding; and where it so happens, their rank impoverishes them, by the expence which is requisite for its support. Yet, as rank affords a certain approximation to fortune, it is certainly better to fix it according to that standard, than to leave it to the arbitrary appointment of the officers of government. Inequality is a less evil than uncertainty.

In that part of the *taille* which fell upon the inferior orders, the latter mode was adopted. This tax was the subject perhaps of more grievous discontent, than any other which yielded an equal revenue. It cannot be supposed that the intendant should not be often swayed by motives of favouritism, private interest, or private resentment; and the very uncertainty to which the people were exposed, formed a severe hardship. They were tempted to conceal their wealth, and even to employ inadequate instruments of trade or agriculture, in order to deceive the watchful eye of the intendant.

House Tax.—In order to avoid the defects incident to the above modes of assessment, rent of houses has been fixed upon as affording the best criterion of the amount of a man's income. It certainly affords a tolerable criterion of his expenditure; and though this may often differ considerably from his means, yet as it is rather the object of government to discourage profuse expenditure, there may be no harm in such inequality.

The most equitable mode of taxing houses, would evidently be in the proportion of their rent. In this country, accordingly, part of the land tax is made to fall upon the rent of houses. This branch of the land tax

tax is subject to the same inequalities, both original and acquired, as the other branches. The assessment, not upon each house, but upon each district, continues invariably the same. In general, it is still higher than upon land. The value of houses, however, has not risen so invariably as that of land; hence, in some districts where the population has decreased, the tax falls with considerable weight. Since that time another tax has been imposed upon houses which is in proportion to the rent, and varies with it. The heaviest tax upon houses, however, is now that which is regulated by the number of *windows*.

At the time of the original imposition of the house tax, it seems to have been considered difficult or impossible to ascertain and follow the fluctuations of the rent. Some obvious and undeniable circumstance, connected with the very form and construction of the house, was therefore selected. The most ancient is the number of hearths. Hearth money is a very ancient duty, and seems to have existed even before the Conquest. Under Charles II. a tax of two shillings on all hearths was granted to the crown for ever. This tax was grievous to the people, on account of the domiciliary visits to which it necessarily subjects them. It had besides the worst kind of inequality, pressing harder on the poor than the rich. A man of 20l. a-year may have two hearths; a man of 200l. not above four or five. A man of 1000l. will scarcely have ten. Hearth money, therefore, was abolished at the Revolution. In its stead was afterwards substituted the window tax, which could be ascertained without entering the house of the contributor. It was soon found, however, to be liable to the same inequality as hearth money. In consideration of this, the rate was greatly increased with the increase of the number of windows, and houses having less than six were entirely exempted. If, however, as would rather appear, the rent can be ascertained in a satisfactory manner, it would seem better to lay the whole of the house tax upon it directly, rather than by any circuitous and doubtful mode.

There are two parts of house rent; the ground rent, or that which is given for the use of the ground on which the house stands; and the building rent, which is paid to the builder, as a remuneration for his trouble and expence. The ground rent, as above observed, must pay a share of the tax; but the building rent cannot be affected by it. The builder must have his profit, otherwise he would turn his capital and industry into another direction. This rule, however, is somewhat modified by the very durable nature of the subject. When the tax is first imposed, it is very probable that the supply of houses may continue for some time nearly adequate to the demand; in which case the proprietor must lower his price in order to get his houses let. As the old houses decay, however, new ones are wanted, which will not be built without an adequate remuneration; and thus the general law will again operate.

Income Tax.—The object of all the different assessed taxes is to make the subject contribute an equitable proportion of his income to the expences of the state. But those which we have above enumerated, though they may procure an approximation to this point, can never attain it with perfect precision. If therefore an income tax, established on just principles, could be collected without any farther grievances, than the always unavoidable payment of the contribution, it would certainly be the most equitable assessment of any, and might with propriety supersede all other taxes of this description. Serious, however, are the difficulties which attend it. The correctness of the estimate must always depend, in a great measure, on the honour of the contributors; but all men are not honest; and the cheating of the king, is, according to the popular code, so venial an offence, that accurate returns cannot, in all cases, be expected. If, on the other hand, the collectors, as in the French *taille*, take upon themselves to form this estimate, a door is opened to arbitrary and oppressive exactions. The impossibility also of escaping the tax by any species of privation makes its weight more sensibly felt, than in those which are in any degree voluntary. For all these reasons, an income tax has hitherto been among the last resources to which a nation has had recourse in its extremest necessity.

Most of the capitation taxes, as formerly observed, partook more or less of the nature of the income tax. The subsidies, so frequent in our early finance, were, like the *taille*, composed, partly according to rank, and partly according to fortune. Among the nobility, alienation of estates was yet rare, and the disproportion between rank and wealth much greater than in subsequent times. The estimate of income seems to have been made by the collectors. Such impositions, however, were ill brooked by a free and turbulent people; the subsidies became more and more unproductive; and at last were entirely given up. The first was imposed under Richard II. in 1370; the last under Charles II. in 1673.

In some small republican states, a tax of this kind is levied, the amount of which is entirely regulated by the good faith of the contributor. At Hamburgh every citizen is said to have placed in the public coffers a sum, which is declared upon oath to be one fourth per cent. of his whole property, which, reckoning interest at five per cent. would be one twentieth of his income. It was not supposed that this mode of collection gave occasion to any fraud. The good faith of the people and their confidence in their government, supplied the place of compulsory laws. The secrecy was considered necessary by a mercantile state; but in some of the small Swiss republics, every citizen declared publicly upon oath the amount of his income, and was assessed accordingly. Such unsuspected good faith could only exist in these small states, where patriotism was ardent, and the confidence of the people in their government entire.

Since the discontinuance of subsidies, nothing of this kind had been attempted in Britain, till the year 1798, when the accumulating weight of public debt suggested to Mr Pitt the necessity of raising a large portion of the supplies within the year. For this purpose, there appeared a necessity for having recourse to an income tax; and so strong a sense was entertained by the nation of the pressing nature of the exigency, that it was submitted to with less reluctance than might have been expected.

An attempt was at first made to connect this imposition with the former assessed taxes. These were to be tripled; but if any person was able to prove, that this charge amounted to more than a tenth of his income, he was relieved from all which exceeded that proportion. At the same time, a voluntary subscription was opened;

opened; but the produce, though honourable to national patriotism, afforded but a slender supply to public wants. These irregular and uncertain approximations towards an income tax were soon given up, and their place supplied by the tax itself, in its own shape.

To obviate the inconveniences of disclosure or arbitrary assessment, measures have been adopted, as effectual probably as any that could be devised. The commissioners of income tax are chosen by the freeholders of the county, or by the electors in a borough, in the same manner as a member of parliament, excepting that a smaller qualification is requisite. To the office of these commissioners, public opinion attaches a certain dignity, which makes it be performed gratuitously, and by the most distinguished persons in the district. These are, by oath, bound to secrecy. The statements are given, in the first instance, by the contributor; but if the commissioners are not satisfied with his return, they can require from him satisfactory explanations. According to the sources of income, the person is assessed at the amount of one year, or at an average of three years. The result of these regulations seems to have been such as to obviate, almost entirely, the chief inconveniences attached to this mode of taxation. The simple payment of the income tax indeed, is most grievously complained of: but the accessories of disclosure, or arbitrary assessment, which were considered as presenting unsurmountable obstacles to this measure, scarcely seem to be complained of at all.

The most important consideration in such a tax relates to the proportion in which it should be paid by the different members of the community. That the lowest orders, who subsist by the labour of their hands, ought to be exempted, seems universally agreed. This would produce the same effect as a tax upon the necessaries of life, the effects of which we shall discuss hereafter. But independent of this class, an equal imposition upon the higher and middling classes of the community would be extreme inequality. The larger the income, the less of it must be spent upon necessaries or common conveniences, and the more upon objects of mere show and ostentation. These last can certainly admit more easily of retrenchment; and as the opulent have a greater stake in the country, it seems reasonable that they should contribute somewhat more in a season of public exigency. A gradation continually augmenting, such as takes place in most of the other assessed taxes, seems to be strongly called for in this. The full proportion of ten per cent. was, from the first, imposed upon incomes of 200l. a-year, and though this was infinitely too low, yet at a subsequent period (in 1806) it was brought down to 150l. This sum, according to the present rate of expence is the very lowest at which any family in the middling rank can possibly be supported. The whole of this class, therefore, a class which has so many claims to the favour of the legislature, is assessed to the very same amount as the highest classes. The first conveniences of life are taxed at the same rate as its most superfluous luxuries. Certainly 1000l. a-year ought to be the first income liable to the very heavy charge of 10 per cent.; and the deficiency hence arising might be very fairly supplied by an increase, gradually augmenting, upon incomes above that amount. Fifteen per cent. perhaps, ought to be the utmost that it ever rose to; but this charge might doubtless be more easily supported by an income of 10,000l. a-year, than half of it by one of 200l. or 300l.

Modifications ought also to take place, according to the source from which the income is derived. That which arises from capital is undoubtedly of greater value than mere professional income. It does not expire with its possessor; it relieves him from the care and anxiety of laying up a provision for his family, and allows him to spend his whole income, when, to another person, it would be the most culpable imprudence. Of all species of capital, land seems to be the most valuable and durable. It stands also most in need of the protection of the state. It generally, too, comes to its possessor by inheritance, and is not the fruit of his own industry. With regard to money, although its value is still much superior to salaries or professional profits, yet it seems rather to be the policy of government to favour its accumulation, which a very great addition of charge might discourage. Money besides is a more moveable species of property than land, or even than professional income. If heavily taxed, the proprietor might withdraw into another country, and his capital, with the industry which it supported, be thus lost to the community.

The present tax makes no distinction between income which dies with its possessor, and income arising from land or capital. Yet such a distinction, if it appeared eligible, might easily be made under the present system of collection, which demands a statement, not only of the amount of income, but of the source from which it arises. The propriety, however, of such a charge demands some consideration. Land, it is true, is well able to bear a considerable share of the public burthens. But land, in this country, and in almost every other, is the subject of a peculiar tax, over and above what is paid by income arising from other sources. If therefore it were also to pay a greater proportion of the income tax, the pressure might become unjustly severe. The land tax in this country amounts to about two millions. Were we to suppose the share of the income paid by land to amount to 5,000,000l. (a large allowance), land would then pay fourteen per cent. which seems as much as can reasonably be exacted. No such burden, at least in any sensible degree, falls upon stock; but for the reasons above stated, the propriety of taxing it heavily seems somewhat equivocal.

According to the original bill, as proposed by Mr Pitt, very liberal exemptions were granted on account of children. To encourage marriage and the rearing of families, has been generally considered by legislators as an important object. From some recent speculations, however, it has appeared doubtful whether it be desirable to remove the obstacles to marriage which arise from the difficulty of subsistence. Whether from these views, or for the mere wish of rendering the tax more productive, this exemption has been gradually circumscribed. The last regulation made respecting it seems to be of a very capricious nature. An allowance of four per cent. is given, but only for the number of children exceeding two. This allowance besides is given, not out of the income tax itself, but out of the assessed taxes. As this tax was entirely a war tax, its abolition was strongly called for after the close of the late war, and was carried in 1816, though opposed by the ministry.

Other Assessed Taxes—A considerable revenue is raised in this country by taxes on men servants, pleasure horses, carriages, dogs, &c. These are all luxuries, the use of which is confined to the most opulent classes; they form, therefore, extremely proper subjects of taxation. The income tax indeed, modified as above stated, might perhaps come instead of all such taxes; but while that tax favours the higher above the middling classes, these in question tend to remedy that inequality. One assessment, however, is of a different nature; that upon labouring horses. It is not likely, and certainly could never be intended, that this tax should restrain the use of these indispensable instruments of agriculture. Neither can the duty fall upon the farmer, who, in all cases, must have his profits. To secure this, he must pay the less rent, in proportion as he pays the more tax; and this duty will finally operate as a land tax. It does not seem, however, to have any advantages above a direct assessment of the same nature. It will bear hard upon the farmer who is in the middle of his lease at the time of its being imposed. If at all heavy, it may have some tendency to limit the use of such horses, and to encourage inferior substitutes. The tax was first laid at 2s. and was justified only by its extreme lightness. It was then gradually raised to 14s.; but a proposal to raise it still higher was thrown out by parliament, and has never been again revived.

2. *Taxes upon Commodities*.—The experience of the discontent excited by direct assessments, and of the difficulty of proportioning them equally, led to the imposition of taxes on consumable commodities. These being laid in the first instance on the commodity at the time of its production or importation, are finally paid by the consumer in the increased price of his goods. No taxes are so little felt, or excite so little discontent. The duty, mingling with the price of the goods, is confounded with it; and, unless when the tax is first imposed, and a sudden rise in consequence takes place, the great mass of the people are even ignorant, how much of what they pay goes to government, and how much constitutes the mere price of the goods. The payment is also made in the most convenient manner, and may be divided into the smallest portions. The power of not paying by ceasing to consume the article taxed, goes a great way in supressing murmurs. Thus, indeed, those whose expence does not keep pace with their fortunes, pay an unequal share of the common contribution. But as the law is generally disposed to recommend economy, it will not perhaps consider this as a serious objection.

For these reasons, the modern system of finance, particularly in this country, where it is so much an object to avoid discontent, has shewn a decided favour to this mode of raising a revenue. And perhaps, upon the whole, they are the best of any; yet the evils with which they are attended are by no means inconsiderable.

1. These taxes take more out of the pocket of the people, in proportion to what they put in that of the public, than any other. This arises from the extensive and minute superintendance which is necessary for their proper collection. For this purpose, a number of officers must be kept, whose salaries form a serious deduction from the produce. In Smith's time, this expence amounted to above $5\frac{1}{2}$ per cent. on the duties of excise, and above 10 per cent. on those of customs. The great augmentation of revenue which has taken place since that time, has been produced more by an increase of duty on articles formerly taxed, than by the introduction of new subjects of taxation. The expence of collection, however, bears still a larger proportion to the amount collected, than either in the stamps or assessed taxes.

There is another way, in which the burden of these taxes is rendered heavier on the public. The merchant or producer advances the tax, often a considerable time before he can dispose of the article. He must therefore have not only indemnification to the amount of the duty, but also profit on the advance which he has made. It is universally observed, that when a new tax is imposed, the article rises more than in proportion to it. The public commonly murmur, and complain that the merchant has merely made the tax a pretence for this disproportionate increase in the price of his article. The truth is, however, that the merchant has a reasonable claim to receive the same profit on that part of his capital, which he has employed in advancing the tax, as upon that which he employed in the original purchase of the commodity.

2. Though the collection of these taxes is less grievous to the great mass of the people, yet it falls heavier on certain classes. These are the dealers in exciseable commodities. As evasion is much easier here than in assessed taxes, a more grinding system of superintendance becomes requisite. The tax-gatherer must have continual access to every part, not only of the workshop, but even of the private house, of the dealer in them. No time, no place, can be exempt from his visits. The power with which he is invested may also, if he be so disposed, give occasion to insolence at least, if not to oppression. Now, as the dealers in these commodities form a part, and even a pretty numerous part of the society, any hardship falling upon them must be a considerable evil. It is felt, besides, though not directly, by the rest of the society. It has already been observed, under the head of POLITICAL ECONOMY, that every disagreeable circumstance attendant on any profession, necessarily raises the rate of wages and profit in that profession. It cannot be supposed, that the dealers in these commodities will submit to the hardships we have noticed without claiming some indemnification in the price of their goods. Thus the first inconvenience will be augmented, and still more will be taken from the people, without any addition to the revenue of the public.

3. These taxes give birth to the trade of smuggling, a trade at once injurious to the public, and ruinous to the individual. Unfortunately the lax state of public morals, in regard to this point offers a strong temptation to grasp at the extraordinary profits which smuggling affords; and from the same cause, the produce of such traffic, when successful, is always sure of a ready sale. This trade, however, in the end, generally ruins not only the fortune, but also the morals of him by whom it is pursued. It trains to the practice of falsehood, perjury, and other vices, without which it cannot be carried on with any chance of success.

4. Such taxes always alter more or less, the natural, and consequently the most advantageous direction of national industry. The tax upon wine must diminish the consumption of that article, and consequently the industry

dustry employed in producing it. Wine indeed is not a commodity of British production; but it must be purchased with British commodities, and if the merchant cannot import it, neither can he afford a market for these British articles which were to be given in exchange for it. Dr Smith seems to imagine, that these taxes produce an absolute defalcation in the amount of national produce; a supposition in which we are inclined to differ from him. Although there is a diminution in the demand for this particular article; yet as the sum levied is not withdrawn from the national expenditure, but is merely transferred from one class of persons to another, it must still support a demand, if not for the same, at least for some other species of commodities. Thus the public will suffer chiefly from the inconveniences attendant on the change. Other restraints, however, for which there is no such compensation, are necessarily attendant on the collection of such duties. In order to render this efficacious, regulations must often be made, as to the manner in which the trade is to be carried on; and it is always to be apprehended, that governments will be more attentive to the security of the revenue, than to the ease of the public. In arbitrary and unenlightened governments, this propensity becomes often so powerful, as to throw the most formidable obstacles in the way of that free circulation of commodities on which the prosperity of trade, and of all industry, essentially depends.

The commodities on which these duties are imposed, may be either the necessaries or the luxuries of life. Between these two divisions the line is not easily drawn. Necessaries, strictly speaking, are confined to those things, without which life cannot be supported or health preserved. Yet, though the philosopher may reason thus, the sovereign cannot confine his people within such strict limits. In regard to food indeed, which is entirely a domestic arrangement, this definition may hold; but in clothing and lodging, the arrangements of which are in the eye of the public, long custom may impose obligations of decency and propriety, which fall little short of absolute necessity. Every thing, in this respect, must be considered as necessary, which a common labouring person of the lowest class cannot want, without incurring the reproach, or exciting the commiseration, of others in the same station.

Taxes upon the necessaries of life have the same effect with taxes upon the wages of labour. Dr Smith, and most other writers, seem to conceive that the immediate effect of such taxes is to raise the wages of labour. But we do not see that such can be the case. Nothing can raise the wages of labour, except an augmentation of the funds destined for its support. But these funds, far from being raised by such taxes, are somewhat diminished. The employers of the poor, being themselves affected by them, will be less able to pay wages than before. It is quite a fallacy to urge, that the labourer, if he does not get sufficient wages, will refuse to work. This might be, if the tax affected only a certain class of labourers, and left the rest free. The labourer, if he could not, over and above the tax, obtain the regular standard rate, would withdraw to other employments. The consequence would be, a rise of the wages of the taxed labour, with a slight fall in those of every other, proportioned to the additional number who would thus be thrown upon it. But where the tax falls equally upon labour of every description, as taxes upon the necessaries of life must do, there is no new quarter to which the labourer can turn; there is nothing either to raise or to lower wages; the supply of and demand for labour continue the same. The effect of the tax is merely to diminish the subsistence of the labourer in proportion to its amount.

This, however, is merely the first effect; for the diminished subsistence will soon begin to act upon the population, which furnishes the supply of labour. Were wages at the time so low as to furnish merely the necessaries of life according to the first definition, that is, such necessaries as it could not subsist without, the inevitable consequence seems to be, that part of the labouring poor must perish for want. Such a calamitous effect seems actually to result, in the crowded population of some eastern empires, when a deficient crop produces a scarcity of subsistence. Happily, however, the labouring poor are seldom so wholly without resource. In general the wages are sufficient to allow them a portion of the other description of necessaries, and even of luxuries, by retrenching which, they can, in the event of such a tax, preserve themselves from absolute starvation. In the end, however, the discouragement to marriage, and difficulty of rearing children, will reduce the population. This reduction, diminishing the supply of labour, will increase wages, till they cover the amount of the tax. The same sum, divided among a smaller number, will make more to each.

High wages operate as a complete tax upon every species of manufactured produce. The manufacturer must charge upon the price of his goods the whole sum which he has paid to his workmen with a profit. In the market of the world, therefore, he must, *cæteris paribus*, be undersold by the manufacturer who resides in a country where labour is cheaper. When these high prices, however, are the result of national prosperity, when they improve the subsistence of the labourer, and lay a foundation for increased population, this disadvantage will weigh very light in the balance. But where they are the result of diminished population, and attended with no improvement in the condition of the labouring poor, they form one of the greatest evils with which a nation can be afflicted.

For these reasons, taxes upon the necessaries of life, though certainly productive, have always been found to be oppressive and ruinous to the prosperity of a state. Luxuries, therefore, form the proper objects of taxation. As every one, if unable to purchase his usual quantity, can either diminish it or abstain altogether, the rise of the article has no tendency to induce such a degree of want, as to check population, and thus cause a rise to the wages of labour. This power of abstinence may indeed lead to a certain inequality; but as this inequality is altogether voluntary, it can neither excite murmuring, nor be considered as a serious hardship. The greatest irregularity is in the case of absentees, by whom such taxes are evaded altogether.

It is not, however, we must observe, from the mere luxuries of shew and ostentation that any important or permanent revenue is to be drawn. These are confined chiefly to persons of large fortune, who are few in number, and are always subject to the influence of fashion, so that little dependence can be placed on their regular consumption. The luxuries from which alone a great

 revenue

Taxation. revenue can be drawn are those which, among the higher and middling classes, have come to be considered almost as necessaries, and which are extensively used by such as are in easy circumstances, even among the lower orders. The only drink necessary for supporting the human constitution in perfect health, seems to be pure water. Men, however, have an universal propensity for something more, both to gratify their taste, and to exhilarate their spirits. Fermented and spirituous liquors, tea, coffee, &c. are had recourse to with this view, and are habitually used in various forms and degrees, by almost every inhabitant of this country. Such articles form therefore the grand basis of this system of taxation.

Of all superfluities, tea seems to be one of the greatest. It affords neither nourishment nor strength, and is generally considered by physicians as injurious to the human constitution. Being imported besides from a remote country, the intercourse with which was, by the mercantile system, stigmatized as injurious, it was considered as every way a fair subject of taxation. Very high duties were accordingly accumulated upon it, which, in 1783, amounted to nearly 30 per cent. on the value, besides an excise of 1s. on every pound. It was found that so high a duty opened a wide door to the smuggling of a commodity of so small bulk, and which was then imported in large quantities by all the neighbouring countries. It was calculated, that though duty was paid on five or six millions of pounds, the consumption of Great Britain amounted to more than double that quantity. A plan was therefore brought forward by Mr Pitt to substitute in its room an additional tax on windows. Smuggling was no doubt checked, and the people were, on the whole, gainers; yet the new tax, being assessed, was more heavily felt by the public than its predecessor, which was only a duty on consumption. Since that time, the exigency of the times has made it again necessary to have recourse to this article; and the tax upon tea has been raised even higher than it was previous to the commutation tax. The diminution, however, of the Indian trade carried on by the other powers, joined to the stricter precautions against smuggling, has prevented its renewal to nearly the same extent as formerly. Tobacco is a still more complete superfluity than tea, yet its use is very extensive. It has therefore been justly considered as one of the properest of all subjects of taxation, and duties have been laid upon it, amounting to five or six times the original value of the article.

Wine is the wholesomest of all fermented liquors, and is even pretty extensively used as a medicine. These circumstances might seem to entitle it to some favour, which, however, it has not experienced. Being entirely a foreign commodity, and being particularly cultivated by a nation long the object of our commercial jealousy, it has incurred the decided hostility of the mercantile system. Duties have been imposed, considerably exceeding the original value. A preference has also been shewn to the wines of Portugal and Spain, (though inferior in quality), which has rendered them the common drink of this country.

Spirits are an article extensively consumed in this country, and on which a high duty may, with the greatest propriety, be imposed, for the purposes not only of revenue, but of moral regulation. They afford no nourishment, and are in the highest degree liable to abuse. They are affected by the general tax on malt; but pay, besides, a considerable one when manufactured. In order to obviate the smuggling which was carried to a great extent in the making of spirits, it has been found advisable to lay the duty on the still, in proportion to its contents. It is paid by the month; and the distiller, when he chooses at any time to intermit his operations for that period, may, by giving due notice to the officers of revenue, avoid being charged. When this plan was first adopted, the duty was comparatively very low. But Mr Pitt soon found himself completely deceived as to the productiveness of this rate of duty. It was raised therefore successively to 162l. its present rate. This system lays the distiller under a temptation to work very rapidly, which is supposed to be injurious to the quality of the spirits. It obliges them also to work without intermission, which they did at first without even the exception of Sunday, till that practice was prohibited by the legislature. It may be proper to notice, that this mode of imposition is confined to Scotland, and that in England it is laid upon the wort or wash.

Fermented liquors from malt are much more useful. They are the most nutritive perhaps of any species of drink, and are on that account well suited to those who are engaged in hard labour. Neither do they offer the same temptations to excess; yet their extensive use, and the necessity of raising a revenue, have led the legislature to consider them as a staple subject of taxation, and they are now charged with a duty of nearly 100 per cent. Dr Smith advises the transference of the whole tax on beer to the malt tax. The latter appears to be less liable to smuggling, and it obviates the present exemption enjoyed by private brewers, which is evidently unreasonable and unequal. The only objection seems to be, that, being imposed at an earlier period of the manufacture, it obliges the manufacturer to lie longer out of his advance, and consequently to demand a greater profit; though this might perhaps be obviated by allowing him a longer credit. The additional taxes, however, imposed upon this article, have been all laid upon beer or porter. In general, it would appear that considerable unnecessary trouble is occasioned by taxing successively different stages of a manufacture. By laying the whole either upon malt, or upon beer, a considerable expence of collection might be saved, without any diminution of the produce.

There are many species of food which cannot, strictly speaking, be considered as necessaries of life, since their place can be supplied by some less expensive substitute. Butcher meat can be supplied by eggs, butter, and other products of milk; wheaten bread by other bread of inferior grains. It may be observed, however, that the imposition of a tax on the superior article would produce an increased demand for the inferior; and consequently raise its price. Accordingly, both butcher meat and wheaten bread are universally numbered among the necessaries of life; nor do we recollect, in the British system of taxation, an instance of solid food liable to duty. This is not the case in other countries, particularly in Holland. Heavy taxes are there imposed upon both articles. All butcher meat pays a duty of more than 7 per cent. of its value. All cattle, besides, pay about 5s. per annum. The tax upon ground corn is also very heavy and undistinguishing. Wheat pays.

pays 104 florins (nearly 9l.) per last. Nor are the inferior grains entirely exempted. Rye pays 42 florins (about 3l. 10s.); barley, beans, and oats, about 2l. Smith is not disposed to censure these heavy impositions, as they may have been rendered necessary by the long wars in which this people were engaged for the support of their independence; and when proper subjects of taxation are exhausted, recourse must be had to improper ones. Upon examining the list, however, of Dutch taxes, we do not find that the taxes upon articles of luxury are so very high, as to have reduced the legislators of that country to such an extremity. The excise upon the *aam* of wine, equal to 40 English gallons, is only 14 florins, or about 1l. 5s. Tobacco, so fair an article of taxation, and so much used in Holland, is taxed only by a slight license, estimated at little more than a halfpenny a pound. Beer and spirits are taxed still more moderately than wine. Besides, even supposing all the articles of luxury to be exhausted, we should conceive it more advisable to have recourse to assessments upon income to the necessary extent, than to duties upon articles of necessity. Accordingly, in this country, a larger revenue in proportion to the population, is now raised than ever was raised in Holland, without having recourse to these ruinous resources.

Clothes and furniture are, to a certain extent, as much necessaries of life as food. The quantity of them, however, which comes under this description, is much less; by far the greater part of the expence which is laid out in this way being for the purpose of convenience at most, if not of mere shew and ostentation. There seems therefore no reason for sparing any, beyond those plainest articles which decency demands from the lowest of the people. This class of commodities, however, has met with peculiar indulgence, in consequence of the favour entertained by the mercantile system for manufactures of every kind. Woollens and hardwares, the two staples of England, have been completely exempted. The same favour has been shown to linen, the staple of the sister kingdoms. Yet, provided a corresponding drawback were allowed on exportation, there does not appear any good reason why the finer sorts of all these fabrics should not be made a subject of revenue. Printed linens and cottons, which have recently been so abundantly produced both in England and Scotland, have been made to pay a considerable tax.

But though the legislature of this country has been thus laudably attentive to avoid touching on the first necessaries of life, there are still several particulars in which it has failed. One of the most important of these is coal, an article of the first utility, the universal fuel of this country, and the material of many of its most important manufactures. It is the less able to bear any duty, because from its local and bulky nature, the expence of transport is often very heavy. London is supplied with coal from Newcastle, which is 300 miles distant. If a bounty could in any case be advisable, it would be in such a case. The legislature, however, has judged otherwise, and has imposed upon every ton of sea-borne coal, a duty of 3s. 6d. Coals carried by land or inland navigation are duty free. Through the exertion of Lord Melville, Scotland, to the north of St Abb's Head, has been freed from this duty; a circumstance which has materially contributed to her rapid prosperity.

Salt, though it may not be requisite for the support of life, has yet, by immemorial usage among civilized nations, been constituted a necessary of life. Notwithstanding this, the small quantity used by each individual, and the minute portions in which it is purchased, make a tax upon it be levied with less murmuring than most other taxes. Governments, taking advantage of this circumstance, have almost universally made it a source of revenue.

In this country the tax on this article presses with the greater severity, as salt is essential to the fishery, one of the most important sources of national wealth. It is true, the duty is drawn back, when salt is so employed: but the facility of smuggling by means of this drawback, produces the necessity of strict regulations, which cramp extremely this branch of industry, especially when carried on in that small scale which is peculiarly suited to it.

Leather, soap, and candles, are also necessaries of life taxed in this country. But though these articles are to a certain extent necessary, by far the greatest consumption of them is for purposes of luxury. Although therefore these taxes do press upon the poor, their weight is not very severe. It might seem easy enough, at least in the first and last of them, to exempt those coarser forms of the commodity, which are used by the lower classes, and thus the deficiency of revenue might be compensated by an increase on the more expensive forms.

Taxes may be imposed either upon exportation or importation. The duties of customs were at first levied on both indiscriminately; but as the mercantile system gained ground, and an anxious desire prevailed to encourage exportation and check importation, in the hope of increasing the specie in the country, all the new duties were laid upon the latter, while the former was more and more exempted. Although this system may not have taken its rise from the most enlightened views, yet no reasonable exception can be taken to it. The taxes imposed by any government ought to fall upon the consumption of its own people, not upon that of others; and as this is a maxim of justice, so it is equally recommended by policy. Were a government to tax its own exported commodities, these commodities would also have to pay the taxes of the country into which they were imported. Loaded with this double burden, they could not advantageously come into competition with similar articles, either the produce of that country, or imported from another which followed a more liberal policy. It is only therefore upon goods imported or produced for home consumption, that these taxes can with propriety fall. From similar views, the materials of manufacture have been generally exempted from duty. We have already observed, that, provided these manufactures be objects of luxury, there is no good reason why they should not pay a tax. But there is an evident advantage in levying the duty *after*, rather than *before*, the manufacturing process. In the latter case, the merchant being obliged to advance it so early, must have a profit on his advance, proportioned to the length of time which elapses till the commodity is fit for sale; and this profit must be paid by the consumer in the price of the goods.

Should we suppose indeed a nation to possess a monopoly of any particular commodity, such a nation might impose

impose a tax on its export, without danger of its merchants being supplanted in the foreign market. Still this could not but be considered as a somewhat illiberal system; and it would also bear hard upon the producer, who would still probably have a double system of duties to pay, since it cannot be supposed that the foreign country should regard these monopolized commodities with peculiar favour.

With the view of following up the principles of the mercantile system, importation duties have often been laid upon goods, so heavy as to amount to a prohibition. Such duties are not intended to produce any revenue, but to favour some home manufacture, or to injure that of some foreign nation, which is an object of commercial jealousy. In the same manner, bounties are given to forward the growth of some branch of industry, which is the object of peculiar favour. In both cases, the revenue is sacrificed, without any real advantage accruing to the public. The industry and capital of the nation are thus turned from their natural direction into one which is less advantageous, and the public is injured instead of being benefited.

It is an undoubted principle, that whether the tax be paid at the time of importation, or at manufacture, it ought to be paid only once. Some governments, profoundly ignorant of the true principles of political economy, have repeated the imposition at every successive sale of the property. This is obviously unequal. The value of property, and the frequency of its transference, are two things altogether distinct. One species of goods may thus come to pay ten or twelve times as much as another of the same value. But great as is its inequality, its impolicy is still more glaring. It forms the most powerful check to that free interchange of commodities which is the very soul of all industry. It tends to confine the consumption of every article to the place of its production, and thus to exclude all those benefits which arise from the extension of the market. Of this ruinous nature is the Spanish *alcavala*, which consists in an imposition, originally of 10, but now only of 6 per cent. on every sale without exception, whatever be the nature of the property, or however frequently repeated. The mere undistinguishing nature of such a tax must be a great evil; but it is rendered far more pernicious by the obstruction which it thus throws in the way of every species of commercial intercourse.

It may be established as a principle in regard to these taxes, that they ought to be as uniform as possible, and not to vary in different parts of the country. Such variations necessarily lead to restraints on the free circulation of commodities. Each province becomes as an independent kingdom, the frontier of which is guarded by customhouses and by chains of officers, through which whoever passes must submit not only to the payment of duties, but to the inconvenience and delay of having his goods searched. Such was the case both in France and in Spain, where each province having formerly been separate and independent, retained still its distinct system of taxation. The transporting of goods from one province to another was like exporting them to a foreign country; the same barriers of customhouses, duties, and revenue officers, obstructed their passage. One of the circumstances which has most contributed to the prosperity of Great Britain is the uniformity of taxation throughout, and consequently the entire freedom of commerce from one part of the island to the other. This was the principal advantage which Scotland derived from the union; and it has been such as fully to compensate for the increased burdens to which that measure subjected her.

Duties upon consumption, instead of being levied upon the trader, may be levied upon the person consuming, who may be made to pay a certain sum as a *license* to use the commodity. Such a mode of levy has some of the advantages of assessed taxes, in regard to the facility and cheapness of collection. It is still also in some degree spontaneous; but it must obviously be, in most cases, very unequal. Of two persons, who should pay the same sum for a license to use wine, one might consume twenty times the quantity of the other. A license has besides the disadvantage of being paid all at once, and of being more sensibly felt than taxes which confound themselves with the price of the commodity. In general, therefore, it is a much less eligible form. There are a few instances, however, of very costly and durable goods, such as coaches, plate, &c. where it is found to be the most convenient. Wine and other liquors, when consumed in taverns, may, it is supposed, be fairly required to pay more than when consumed in private houses. An attempt, however, to proportion this addition to the quantity consumed, would be attended with unsurmountable difficulties. A license is therefore required to be taken out by innkeepers who deal in these articles. This tax falls with equal weight upon the great and small dealers; but it may be rather considered as desirable to check the multiplication of the last.

3. *Stamp Duties.*—Under the title of stamp duties, we would include all those which fall upon the deeds which regulate the transference of property.

The first of these duties, of which we find any mention, are those upon testamentary donations. A law of Augustus imposed the *vicesima hereditatum*, or twentieth penny, upon all inheritances. It was in Holland, however, which was pressed by the severest necessity of raising a revenue, and not very discriminating in the mode of doing it, that the system of *stamp* duties first originated, and was carried to a formidable extent. Such were the difficulties of that state, that they are said to have publicly proposed a reward to any one who should suggest a new source of revenue. This plan was proposed and approved. From Holland it was, in 1671, imported into this country, and has since become one of the great sources of public income. In other countries, deeds regarding the transference of property are required to be entered in a public register, and the tax laid on the registration. A considerable revenue was thus raised in France. Auction duties upon the sale of property, both moveable and immoveable, though somewhat different in point of form, coincide exactly with these taxes in their essence and tendency.

Taxes of this nature are attended with considerable conveniences to the contributors. From the nature of the transaction, there must always be money in hand with which the tax can be paid; and the time of payment is thus the most convenient of any. In many cases, the sum to be paid at a time is small. It is only part of the society which is liable to them to any great extent, and these only occasionally; they are not felt as intrenching on daily and habitual comforts; nor do they

they excite that general murmur, which is alone formidable to government. It is not to be wondered at, therefore, if the latter should avail themselves of this passive disposition in the people for the extension of this source of supply. The truth is, however, that in all essential respects, these taxes are among the most improper of any.

1. They are unequal, inasmuch as the value of any property is altogether unconnected with the frequency of its transference. This inequality would subsist, even though the stamp duty were always in exact proportion to the value of the property. But this is, in general, far from being strictly the case. It may be noticed, however, that in the recent additions made to the stamp duties in this country, the principle of equality has been more attended to.

2. The greater part of such taxes fall not upon the income, but upon the capital of the country; not upon that fund which may be properly and safely expended, but upon that, the expenditure of which must be ultimately ruinous. This circumstance is peculiar to these duties; for though others, when very severe, may oblige the contributor to encroach on his capital, they alone fall directly and immediately upon that fund. An objection of this nature would alone be sufficient to dissuade their adoption.

3. Such taxes, when they fall upon moveable goods, have a direct tendency to check commerce, and through it every kind of industry. They are then a complete *alcavala*, differing from that ruinous impost only by being more moderate.

Thus we find, that the facility of collection, and the avoiding of discontent, which have tempted modern governments to extend so much this source of revenue, are altogether fallacious advantages, and bear no proportion to the ill consequences with which such taxes are necessarily attended. It would therefore be much better that the duties upon the transference of moveable goods should be laid upon their original production. They would thus pay only once, and no impediment would be thrown in the way of their free circulation. Duties upon the sale of land and other immoveable goods ought to be converted into assessed taxes, payable on their yearly use. In the present circumstances of this country indeed, it is perhaps too much to expect that taxes, which are paid without much murmuring, should be taken off; but the considerations now stated ought certainly to deter from any farther addition to them.

Legacies from any distant relation are a sort of accidental and unexpected advantage, and it is therefore to be supposed, that the person receiving will have secured a regular source of subsistence independent of them. He will not therefore, it is likely, be disposed to complain very grievously, if this extrinsic source of wealth be somewhat diminished by a duty to government. In this country, accordingly, such legacies are chargeable with a duty of 10 per cent. This tax seems one of the most unexceptionable of the kind, and only liable to the objection of falling upon capital. It is otherwise with money left by a father or other very near relation. The death of such persons commonly diminishes, instead of increasing, the wealth of the family; and the sum left forms often the sole dependence of a great part of it. Accordingly, in Great Britain, the duty on legacies to the nearest relations is very slight, and gradually increases as the consanguinity becomes more remote.

Receipt stamps, though they are formally paid by the seller, fall really upon the purchaser. The merchant, who must have his profit, will calculate the expence which he is likely to be at in stamps, and will lay a corresponding augmentation on the price of his goods. Such taxes, unless very heavy, will fall upon income only, not upon capital.

Bills of exchange, and policies of insurance, being necessary instruments of trade, seem as improper subjects of taxation as can well be. The only thing tolerable in these taxes, as imposed in this country, is their moderation.

Auction duties seem liable to every objection which can be stated against taxes of this description. They are the more severe, as they must fall often upon unfortunate persons who are reduced to the necessity of disposing, in this manner, of their property.

Stamps upon law proceedings tend to increase the expence of obtaining justice, which is already complained of in general as too heavy. They may indeed be supposed to be of some use in checking a litigious spirit; but this seems already to be done pretty effectually by the other expences attendant on judicial proceedings.

Taxes upon indentures, or upon the entrance to any profession, produce a monopoly to the persons exercising that profession. They thus tend at once to raise the price of their labour and of its fruits, and to diminish the necessity of qualifying themselves for its performance. The chief weight of these taxes falls upon the persons exercising the profession of the law. The public are apt to regard such persons with a degree of hostility, which has probably induced government to believe it might tax them without danger of exciting any general murmur. The truth is, however, that these taxes fall not on the practitioners themselves, but on those who complain of them, on the persons engaged in litigation; so that their effect is precisely the same with that of taxes on law proceedings. It differs from them only as a license differs from a duty upon commodities, and is less eligible, as falling more unequally. The persons who pay the same sum at entrance, carry on their profession with very different degrees of success.

Some impositions, which assume the form of stamp duties, are in reality taxes upon commodities. Such are the game duty, the duty on cards, hats, plate, &c. But most of these seem to be unexceptionable subjects.

TAXUS, the YEW-TREE, a genus of plants belonging to the class diœcia, and in the natural system ranging under the 51st order, *Coniferæ*. See BOTANY *Index*.

TAY, in Latin *Tavus*, or *Taus*, the largest river in Scotland, rises in Braidalbane, on the frontiers of Lorn; and having in the passage of a few miles augmented its stream by the accession of several small rills, spreads itself into the lake called *Loch Dochart;* out of which having run but a little space, it expands itself again. Leaving this second lake, it rolls some miles with a considerable body of water, and then diffuses itself in the spacious Loch Tay; which, reckoning from the sources of the river, is 24 miles in length, though, strictly speaking,

speaking, the lake is but 13: almost as soon as it issues from hence, it receives the river Lyon, coming out of Loch Lyon, and running through Glen Lyon; which, having travelled in a manner parallel to it, from its source, for a space of 25 miles, at length joins the Tay as it enters Athol, which it next traverses, and, directing its course in a manner due east, receives almost all the waters of that country. Bending then to the south, at the distance of six miles, it reaches Dunkeld; which, in the language of our ancestors, signifies "the hill of hazels," was the very centre of the old Caledonia, and is at present esteemed the heart of the Highlands. The river is very broad here, insomuch that there is a ferry-boat over it at each end of the town. Declining still to the south-east, with a winding course, for above 12 miles, the Tay receives a large supply of waters from the county of Angus; and then running south west for eight miles more, is joined in that space by several rivers, the most considerable of which is the Almond. Turning then to the south-east, at the distance of about three miles, this copious river comes with a swelling stream to Perth.

The Tay, continuing still a south-east course, receives, a few miles below Perth, the river Erne; which, issuing from a loch of the same name, traverses the county of Strathern, and passes by Abernethy, once the capital of the Pictish kingdom. Swelled by the waters of this last river, the Tay, running next directly east, enlarges itself till it becomes about three miles broad; but contracts again before the town of Dundee; soon after which it opens into the German ocean. At the entrance of the frith, there are sands both on the north and on the south side; the former styled *Goa*, the latter *Aberlay* and *Drumlan*; and before these, in the very mouth of the frith, those which are called the *Cross Sands*. At Buttonness, which is the northern promontory, there are two light-houses. The space between the north and the south sands may be near a mile, with about three fathoms water; but being within the frith, it grows deeper, and in the road of Dundee is full six fathoms. The frith of Tay is not indeed so large or so commodious as that of Forth, but from Buttonness to Perth it is not less than 40 miles; and the whole may be, without any great impropriety, styled a harbour, which has Fife on one side, and the shires of Perth and Angus on the other, both very fertile and pleasant countries.

TAYLOR, Dr Jeremy, bishop of Down and Connor in Ireland, was the son of a barber at Cambridge, where he was educated. Upon entering into orders, he became divinity lecturer of St Paul's in London; and was, by the interest of Archbishop Laud, elected fellow of All-Souls college, Cambridge, in 1636. Two years after he became one of the chaplains of the archbishop, who bestowed on him the rectory of Uppingham in Rutlandshire. In 1642, he was chaplain to the king; and a frequent preacher before him and the court at Oxford. He afterwards attended in the king's army in the condition of a chaplain. Upon the declining of his majesty's cause, he retired into Wales, where he was permitted to officiate as minister, and to keep a school, in order to maintain himself and his children. In this retirement he wrote several of his works. Having spent several years there, his family was visited with sickness; and he lost three sons of great hopes within the space of two or three months. This affliction touched him so sensibly, that it made him desirous to leave the country; and, going to London, he for a time officiated in a private congregation of loyalists to his great hazard. At length meeting with Edward lord Conway, that nobleman carried him over with him into Ireland, and settled him at Portmore, where he wrote his *Ductor Dubitantium*. Upon the Restoration he returned to England. Soon after, he was advanced to the bishopric of Down and Connor in Ireland; and had the administration of the see of Dromore granted to him. He was likewise made privy-counsellor and vice-chancellor of the university of Dublin; which place he held till his death. He died of a fever at Lisnegarvy in 1667, and was interred in a chapel which he himself had built on the ruins of the old cathedral of Dromore.

Taylor, *Dr Brook*, was born at Edmonton, August 18th 1685. He was the son of John Taylor, Esq. of Bifrons house in Kent, by Olivia, daughter of Sir Nicholas Tempest, of Durham, Baronet. His grandfather, Nathaniel Taylor, was one of those puritans whom "Cromwell thought fit to elect by a letter, dated June 14th 1653, to represent the county of Bedford in parliament." The character of his father partook in no small degree of the austerity that had been transmitted to him in the line of his ancestors, and by the spirit of the times in which they lived; and to this cause may be ascribed the disaffection which sometimes subsisted between the father and even such a son as is the subject of this article. The old gentleman's morose temper, however, yielded to the powers of music; and the most eminent professors of the art in that period were hospitably welcomed in his house. His son Brook was induced, by his natural genius, and by the disposition of his father, which he wished by all the means in his power to conciliate, to direct his particular attention to music; and he became in very early life a distinguished proficient in it.—"In a large family piece, he is represented at the age of 13 sitting in the centre of his brothers and sisters; the two elder of whom, Olivia and Mary, crown him with laurel, bearing the insignia of harmony."

To music he added another accomplishment, in which he equally excelled. "His drawings and paintings, of which some are still preserved, require not those allowances for error or imperfection with which we scan the performances of even the superior *dilettanti*;—they will bear the test of scrutiny and criticism from artists themselves, and those of the first genius and professional abilities." Though he was eminent in the culture and practice both of music and drawing in his early youth, his whole attention was not occupied by these fascinating arts. His classical education was conducted at home under a private tutor; and his proficiency in the ordinary branches of the languages and the mathematics was so great, that he was deemed qualified for the university at the early age of 15.

In 1701 he was entered a fellow commoner of St John's College, Cambridge. At that period mathematics engaged more particularly the attention of the university; and the examples of eminence in the learned world, derived from that branch of science, attracted the notice and roused the emulation of every youth possessed of talents and of application. We may presume, that Brook Taylor, from the very hour of his admission at

Taylor.

at college, adopted the course of study which a Machin, a Keil, and, above all, a Newton, had opened to the mind of man, as leading to discoveries of the celestial system.—That he applied early to these studies, and without remission, is to be inferred from the early notice and kind attention with which he was honoured by those eminent persons, and from the extraordinary progress which he made in their favourite science."

In 1708 he wrote his treatise On the Centre of Oscillation, which was not published in the Philosophical Transactions till some years afterwards. In 1709, he took his degree of Bachelor of Laws. In 1712, he was chosen a Fellow of the Royal Society. During the interval between these two periods, he corresponded with Professor Keil on several of the most abstruse subjects of mathematical disquisition. Sir William Young informs us, that he has in his possession a letter, dated in 1712, addressed to Mr Machin, which contains at length a solution of Kepler's problem, and marking the use to be derived from that solution. In this year he presented to the Royal Society three different papers: one On the Ascent of Water between two Glass Planes; a second, On the Centre of Oscillation; and a third, on the Motion of a stretched String. It appears from his correspondence with Keil, that in 1713 he presented a paper on his favourite subject of Music; but this is not preserved in the Transactions.

His distinguished proficiency in those branches of science, which engaged the particular attention of the Royal Society at this period, and which embroiled them in contests with foreign academies, recommended him to the notice of its most illustrious members; and in 1714 he was elected to the office of secretary. In this year he took at Cambridge his degree of Doctor of Laws: and at this time he transmitted, in a letter to Sir Hans Sloane, An Account of some curious Experiments relative to Magnetism; which, however, was not delivered to the Society till many years afterward, when it was printed in the Transactions. His application to those studies to which his genius inclined was indefatigable; for we find that in 1715 he published in Latin his *Methodus Incrementorum;* also a curious essay preserved in the Philosophical Transactions, entitled An Account of an Experiment for the Discovery of the Laws of Magnetic Attraction; likewise a treatise well known to mathematicians, and highly valued by the best judges, on the Principles of Linear Perspective. In the same year (such were his admirable talents, and so capable were they of being directed to various subjects), he conducted a controversial correspondence with the Count Raymond de Montmort, on the Tenets of Malebranche; which occasioned his being particularly noticed in the eulogium pronounced by the French academy on the decease of that eminent metaphysician.

The new philosophy of Newton (as it was then called) engaged the attention of mathematicians and philosophers both at home and abroad. At Paris it was in high estimation; and the men of science in that city were desirous of obtaining a personal acquaintance with the learned secretary of the Royal Society, whose reputation was so generally acknowledged, and who had particularly distinguished himself in the Leibnitzian or German controversy, as we may denominate it, of that period. In consequence of many urgent invitations, he determined to visit his friends at Paris in the year 1716. He was received with every possible token of affection and respect; and had an opportunity of displaying many traits of character, which mark the general scholar and accomplished gentleman, as well as the profound mathematician. His company was courted by all "who had temper to enjoy, or talents to improve, the charms of social intercourse." Besides the mathematicians, to whom he had always free access, he was here introduced to Lord Bolingbroke, the Count de Caylus, and Bishop Bossuet.

Early in 1717 he returned to London, and composed three treatises, which were presented to the Royal Society, and published in the 30th volume of the Transactions. About this time his intense application had impaired his health to a considerable degree; and he was under the necessity of repairing, for relaxation and relief, to Aix-la-Chapelle. Having likewise a desire of directing his attention to subjects of moral and religious speculation, he resigned his office of secretary to the Royal Society in 1718.

After his return to England in 1719, he applied to subjects of a very different kind from those that had employed the thoughts and labours of his more early life. Among his papers of this date, Sir William Young has found detached parts of A Treatise on the Jewish Sacrifices, and a dissertation of considerable length On the Lawfulness of eating Blood. He did not, however, wholly neglect his former subjects of study, but employed his leisure hours in combining science and art; with this view he revised and improved his treatise on Linear Perspective. Drawing continued to be his favourite amusement to his latest hour; and it is not improbable, that his valuable life was shortened by the sedentary habits which this amusement, succeeding his severer studies, occasioned. "He drew figures with extraordinary precision and beauty of pencil. Landscape was yet his favourite branch of design. His original landscapes are mostly painted in water colours, but with all the richness and strength of oils. They have a force of colour, a freedom of touch, a varied disposition of planes of distance, and a learned use of aerial as well as linear perspective, which all professional men who have seen these paintings have admired."

The work of Dr Brook Taylor in linear perspective was censured by Bernoulli, in a treatise published in the Acts of Leipsic, as "abstruse to all, and as unintelligible to artists for whom it was more especially written." It must be acknowledged that this excellent work, for so it deserves to be called, was not level to the apprehensions of practitioners in the art of drawing and design; but it was much esteemed by mathematicians. Three editions of it have been published: and as it is now scarce, a republication of it in its most improved and perfect state would be very acceptable. Mr Kirby, however, has made it more plain and popular, in his treatise entitled "Brook Taylor's Perspective made easy;" and this book, detailing and illustrating the principles of the original work, has been the *vade mecum* of artists. Dr Brook Taylor was incensed by the invidious attacks of Bernoulli; and he published An Apology against J. Bernoulli's Objections, which may be seen in the 30th volume of the Philosophical Transactions. Bernoulli, with his usual envy of British mathematicians, had disputed our author's right to his own work.

work. We have no reason to doubt Dr Taylor's claims to the undecided discovery of the method which he describes, though he is not an original inventor. This method was long before published by Guido Ubaldi, in his Perspective, printed at Pesaro in 1600; where it is delivered very clearly, and confirmed by most elegant demonstrations; and where it is actually applied to the art of delineating the scenes of a theatre.

Toward the end of the year 1720, Dr Brook Taylor accepted the invitation of Lord Bolingbroke to spend some time at La Source, a country-seat near Orleans, which he held in right of his wife, the widow of the Marquis de Villette, nephew of Madame de Maintenon. In the next year he returned to England, and published the last paper which appears with his name in the Philosophical Transactions, entitled, An Experiment made to ascertain the Proportion of Expansion of Liquor in the Thermometer, with regard to the degree of Heat.

In 1721, Dr Brook Taylor married Miss Bridges of Wallington in the county of Surry, a young lady of good family, but of small fortune; and this marriage occasioned a rupture with his father, whose consent he had never obtained. The death of this lady in 1725, and that of an infant son, whom the parents regarded as the presage and pledge of reconciliation with the father, and who actually proved such, deeply affected the sensibility of Dr Taylor. However, during the two succeeding years he resided with his father at Bifrons, where "the musical parties, so agreeable to his taste and early proficiency, and the affectionate attentions of a numerous family welcoming an amiable brother, so long estranged by paternal resentment, not only soothed his sorrows, but ultimately engaged him to a scene of country retirement, and domesticated and fixed his habits of life. He could no more recur to the desultory resources, and cold solace of society, which casual visits, slight acquaintance, and distant friendships, afford the man—who hath *none to make and cheer a constant home*."

In 1725 he formed a new connection; and with the full approbation of his father and family, married Sabetta, daughter of John Sawbridge, Esq. of Olantigh, in Kent. In 1729, on the death of his father, he succeeded to the family estate of Bifrons. In the following year he lost his wife in childbed. The daughter whose birth occasioned this melancholy event survived, and became the mother of Sir William Young, to whom we owe these memoirs of his grandfather.

In the interval that elapsed between the years 1721 and 1730, no production by Brook Taylor appears in the Philosophical Transactions; nor did he publish in the course of that time any work. His biographer has found no traces of his learned labour, excepting a Treatise of Logarithms, which was committed to his friend Lord Paisley (afterward Abercorn), in order to be prepared for the press; but which probably never was printed. His health was now much impaired; relaxation became necessary, and he was diverted by new connections from the habit of severe study, which had distinguished the early period of his life, and which had contributed to contract the duration of it. Happy in the social circle of domestic enjoyment, and devoting his attention to business or amusement as they occurred, his application and his literary emulation seem to have declined. He did not long survive the loss of his second wife; and his remaining days were days of increasing imbecility and sorrow.

"The essay entitled *Contemplatio Philosophica*, published by Sir William Young, 1793, appears to have been written about this time, and probably with a view to abstract his mind from painful recollections and regret. It was the effort of a strong mind, and is a most remarkable example of the close logic of the mathematician applied to metaphysics. But the blow was too deep at heart for study to afford more than temporary relief. The very resource was hurtful, and intense study but accelerated the decline of his health. His friends offered every comfort; in particular Lord Bolingbroke pressed his consolation, and sought to call his mind from regret of domestic endearments to social friendship at Dawley.

The attention and kindness of his friends, however, could not ward off the approaches of dissolution. "Having survived his second wife little more than a year, Dr Brook Taylor died of a decline in the 46th year of his age, December the 29th 1731, and was buried in the church-yard of St Ann's Soho. I am spared (says his descendant) the necessity of closing this biographical sketch with a prolix detail of his character: in the best acceptation of duties relative to each situation of life in which he was engaged, his own writings, and the writings of those who best knew him, prove him to have been the finished Christian, gentleman, and scholar."

Taylor-Bird. See Motacilla, Ornithology *Index*.

TEA, the dried leaves of the tea plant.—A commodity with which we are so well acquainted, which affords a beverage so generally used and so generally agreeable, and which forms so considerable an article of commerce, must excite curiosity to know something of its history, and of the nature of the plant from which it is obtained.

The tea plant is a native of Japan, China, and Tonquin, and has not, as far as we can learn, been found growing spontaneously in any other parts of the world. Linnæus arranged it under the class of *polyandria*, and order of *monogynia*, and Thunberg, one of the most distinguished pupils of that illustrious botanist, who resided 16 months in Batavia and Japan, has classed it in the same manner as his master. Several of the British botanists, on the other hand, refer it to the order of *trigynia;* deriving their authority from a plant in the duke of Northumberland's garden at Sion-house, which had three styles.

Linnæus says that there are two species of the tea plant; the *bohea*, the corolla of which has six petals; and the *viridis* or green tea, which has nine petals. Thunberg makes only one species, the bohea, consisting of two varieties; the one with broad and the other with narrow leaves.

The tea plant, which is an evergreen, grows to the height of five or six feet; Le Compte says ten or twelve. The leaves, which are the only valuable part of it, are about an inch and a half long, narrow, indented, and tapering to a point, like those of the sweet briar, and of a dark green colour. The root is like that of the peach tree, and its flowers resemble those of the white wild rose. The stem spreads into many irregular branches.

branches. The wood is hard, of a whitish green colour, and the bark is of a greenish colour, with a bitter, nauseous, and astringent taste. The fruit is small, and contains several round blackish seeds, about the bigness of a bean or large pea.

This plant delights in valleys, is frequent on the sloping sides of mountains and the banks of rivers, where it enjoys a southern exposure. It flourishes in the northern latitudes of Pekin as well as round Canton, but attains the greatest perfection in the mild temperate regions of Nankin. It is said only to be found between the 30th and 45th degree of north latitude. In Japan it is planted round the borders of fields, without regard to the soil; but as it is an important article of commerce with the Chinese, whose fields are covered with it, it is by them cultivated with care. The Abbé Rochen says, it grows equally well in a poor as in a rich soil; but that there are certain places where it is of a better quality. The tea which grows in rocky ground is superior to that which grows in a light soil; and the worst kind is that which is produced in a clay soil. It is propagated by seeds; from six to twelve are put into a hole about five inches deep, at certain distances from each other. The reason why so many seeds are sown in the same hole is said to be, that only a fifth part vegetate. Being thus sown, they grow without any other care. Some, however, manure the land, and remove the weeds; for the Chinese are as fond of good tea, and take as much pains to procure it of an excellent quality, as the Europeans do to procure excellent wine.

The leaves are not fit for being plucked till the shrub be of three years growth. In seven years it rises to a man's height; but as it then bears but few leaves, it is cut down to the stem, and this produces a new crop of fresh shoots the following summer. We are informed by Kœmpfer, that there are three seasons in which the leaves are collected in the isles of Japan, from which the tea derives different degrees of perfection.

The first gathering commences at the end of February or beginning of March. The leaves are then small, tender, and unfolded, and not above three or four days old: these are called *ficki-tsiaa*, or "tea in powder," because it is pulverised; it is also called *imperial tea*, being generally reserved for the court and people of rank; and sometimes also it is named *bloom tea*. It is sold in China for 20d. or 2s. per pound. The labourers employed in collecting it do not pull the leaves by handfuls, but pick them one by one, and take every precaution that they may not break them. However long and tedious this labour may appear, they gather from 4 to 10 or 15 pounds a-day.

The second crop is gathered about the end of March or beginning of April. At this season part of their leaves have attained their full growth, and the rest are not above half their size. This difference does not, however, prevent them from being all gathered indiscriminately. They are afterwards picked and assorted into different parcels, according to their age and size. The youngest, which are carefully separated from the rest, are often sold for leaves of the first crop, or for imperial tea. Tea gathered at this season is called *too-tsiaa*, or "Chinese tea," because the people of Japan infuse it, and drink it after the Chinese manner.

The third crop is gathered in the end of May or in the month of June. The leaves are then very numerous and thick, and have acquired their full growth. This kind of tea, which is called *ben-tsiaa*, is the coarsest of all, and is reserved for the common people. Some of the Japanese collect their tea only at two seasons of the year, which correspond to the second and third already mentioned; others confine themselves to one general gathering of their crop, towards the month of June: however, they always form afterwards different assortments of their leaves.

The finest and most celebrated tea of Japan is that which grows near Ud-si, a small village situated close to the sea, and not far distant from Meaco. In the district of this village is a delightful mountain, having the same name, the climate of which is said to be extremely favourable to the culture of tea; it is therefore inclosed by a hedge, and surrounded with wide ditches, which prevent all access to it. The tea shrubs that grow on this mountain are planted in regular order, and are divided by different avenues and alleys.

The care of this place is entrusted to people who are ordered to guard the leaves from dust, and to defend them from the inclemency of the weather. The labourers who are appointed to collect the tea abstain from every kind of gross food for some weeks before they begin, that their breath and perspiration may not in the least injure the leaves. They gather them with the most scrupulous nicety, and never touch them but with very fine gloves. When this choice tea has undergone the process necessary for its preparation, it is escorted by the superintendant of the mountain and a strong guard to the emperor's court, and reserved for the use of the imperial family.

As the tea shrub grows often on the rugged banks of steep mountains, access to which is dangerous, and sometimes impracticable, the Chinese, in order to come at the leaves, are said to use a singular stratagem: These steep places are generally frequented by great numbers of monkeys, which being irritated and provoked, to revenge themselves tear off the branches, and shower them down upon those who have insulted them. The Chinese immediately collect these branches, and strip them of their leaves.

When the tea leaves have been collected, they are exposed to the steam of boiling water; after which they are put upon plates of copper, and held over the fire until they become dry and shrivelled, and appear such as we have them in Europe. According to the testimony of Kœmpfer, tea is prepared in the same manner in the isles of Japan. "There are to be seen there (says this traveller) public buildings erected for the purpose of preparing the fresh gathered tea. Every private person who has not suitable conveniences, or who is unacquainted with the operation, may carry his leaves thither as they dry. These buildings contain a great number of small stoves raised about three feet high, each of which has a broad plate of iron fixed over its mouth. The workmen are seated round a large table covered with mats, and are employed in rolling the tea leaves which are spread out upon them. When the iron plates are heated to a certain degree by the fire, they cover them with a few pounds of fresh gathered leaves, which being green and full of sap, crackle as soon as they touch the plate. It is then the business of the workman to stir them with his naked hands as quickly as possible, until they become so warm that he cannot

 easily

Tea.

easily endure the heat. He then takes off the leaves with a kind of shovel, and lays them upon mats. The people who are employed in mixing them, take a small quantity at a time, roll them in their hands always in the same direction; while others keep continually stirring them, in order that they may cool sooner, and preserve their shrivelled figure the longer. This process is repeated two or three times, and even oftener, before the tea is deposited in the warehouses. These precautions are necessary to extract all the moisture from the leaves."

The people of Japan and China generally keep their tea a year before using it, because, when quite fresh and newly gathered, it possesses a narcotic quality which hurts the brain. Imperial tea is generally preserved in porcelain vases, or in leaden or tin canisters covered with fine mats made of bamboo. Common tea is kept in narrow-mouthed earthen pots; and coarse tea, the flavour of which is not so easily injured, is packed up in baskets of straw.

An infusion of tea is the common drink of the Chinese; and indeed when we consider one circumstance in their situation, we must acknowledge that Providence has displayed much goodness in scattering this plant with so much profusion in the empire of China. The water is said to be unwholesome and nauseous, and would therefore perhaps, without some corrective, be unfit for the purposes of life. The Chinese pour boiling water over their tea, and leave it to infuse, as we do in Europe; but they drink it without any mixture, and even without sugar. The people of Japan reduce theirs to a fine powder, which they dilute with warm water until it has acquired the consistence of thin soup. Their manner of serving tea is as follows: They place before the company the tea equipage, and the box in which this powder is contained: they fill the cups with warm water, and taking from the box as much powder as the point of a knife can contain, throw it into each of the cups, and stir it with a tooth-pick until the liquor begins to foam; it is then presented to the company, who sip it while it is warm. According to F. du Halde, this method is not peculiar to the Japanese; it is also used in some of the provinces of China.

The first European writer who mentions tea is Giovanni Botero, an eminent Italian author, who published a treatise about the year 1590, Of the Causes of the Magnificence and Greatness of Cities. He does not indeed mention its name, but describes it in such a manner that it is impossible to mistake it. "The Chinese (says he) have an herb out of which they press a delicate juice, which serves them for drink instead of wine: it also preserves their health, and frees them from all those evils which the immoderate use of wine produces among us *."

* *Anderson's Commerce*, vol. i. p. 138.

Tea was introduced into Europe in the year 1610 by the Dutch East India Company. It is generally said, that it was first imported from Holland into England, in 1666, by the lords Arlington and Ossory, who brought it into fashion among people of quality. But it was used in coffee-houses before this period, as appears from an act of parliament made in 1660, in which a duty of 8d. was laid on every gallon of the infusion sold in these places. In 1666 it was sold in London for 60s. per pound, though it did not cost more than 2s. 6d. or 3s. 6d. at Batavia. It continued at this price till 1707. In 1715 green tea began to be used; and as great quantities were then imported, the price was lessened, and the practice of drinking tea descended to the lower ranks †. In 1720 the French began to send it to us by a clandestine commerce. Since then the demand has been increasing yearly, and it has become almost a necessary of life in several parts of Europe, and among the lowest as well as the highest ranks.

† *Hanway's Journal.*

The following table shews the quantity of tea imported annually into Great Britain and Ireland since 1717:

From 1717 to 1726	-	700,000 lbs.
1732 to 1742	-	1,200,000
1755 near	-	4,000,000
1766 -	-	6,000,000
1785 about	-	12,000,000
1794 from		16 to 20,000,000

Since 1794 the increase has still been very great. The whole revenue derived from tea in Great Britain in the year ending 5th January 1819, was 3,309,845l.

Besides the quantities imported into Britain and Ireland, much has been brought to Europe by other nations. In 1766 the whole tea imported into Europe from China amounted to 17 millions of pounds; in 1785 it was computed to be about 19 millions of pounds ‡.

‡ *Raynal*, vol. i. and *Robertson's India.*

Several researches have been made in Europe to determine whether the tea plant grows spontaneously, but these researches have been hitherto in vain. When Captain Cook visited Teneriffe in his last voyage, Mr Anderson his surgeon was informed by a gentleman of acknowledged veracity, that a shrub is common near Santa Cruz which agrees exactly with the description given of the tea-plant by Linnæus. It is considered as a weed, and large quantities are rooted out of the vineyards every year: But the Spaniards who inhabit the island sometimes make use of it, and ascribe to it all the qualities of the tea imported from China.

Many attempts have been made to introduce this valuable plant into Europe; but from want of proper precautions most of these attempts have miscarried. The seeds, being of an oily nature, are apt to grow rancid during a long voyage, unless proper care is taken to preserve them. There are two methods of preserving these seeds: The first is, to inclose them in wax after they have been dried in the sun; the second is, to leave them in their husks, and shut them up closely in a box made of tin: but neither of these methods has been attended with general success, whatever care has been taken to obtain fresh seeds, or to preserve them. The best method would be, to sow fresh seeds in fine light earth immediately on leaving Canton, and to cover them with wire to secure them from rats and other animals that might attack them. The boxes ought not to be too much exposed to the air, nor to that kind of dew which rises from the sea. The earth in the boxes must neither be hard nor dry, and should from time to time be gently watered with fresh or rain water; and when the shoots begin to appear, they ought to be kept in a slight moisture, and sheltered from the sun. The tea-plants to be found in England have been procured by these means only; and though several of the young rising shoots perished, the last method proposed is probably that which may be followed with greatest success.

The finest tea-plant known in England was raised in Kew

Kew gardens; it was carried thither by Sir J. Ellis, who brought it from seed: but the first that ever flourished in Europe was one belonging to the duke of Northumberland at Sion, from a drawing of which our engraving is taken. The plants which are cultivated in the gardens near London thrive well in the green-house during winter, and some stand that season in the open air. Linnæus, who obtained this shrub in its growing state, contrived to preserve it in the open air in the northern latitude of Sweden. France has also procured some plants. There can be no doubt but they would succeed in many countries of Europe, if proper care were paid to their cultivation till they became inured to the climate. It will be a great advantage if we can rear that plant, which can never suffer so much from change of soil as from growing musty during the long voyage from China. Besides, the demand for tea is now become so great, that the Chinese find it necessary, or at least profitable, to adulterate it. Bad tea is now become an universal complaint. The abbé Grosier tells us, that there is a kind of moss which grows in the neighbourhood of the little city of Mang-ing-hien, which is sold as a delicate species of tea. If this delicious commodity is adulterated in China, can we flatter ourselves that none comes to us but what is pure and unmixed? How would our fine ladies like to be told, that instead of tea they drink nothing but the infusion of moss from the rocks of Mang-ing-hien (F)?

Of the chemical qualities and effects of tea on the constitution, many various and opposite opinions have been formed. About a century ago, Bontikoe, a Dutch physician, bestowed extravagant encomiums on the benefits of tea. With him it was good for every thing; and any quantity might be drunk, even to the amount of 200 dishes in a day. Whether Bontikoe in this case acted as a physician, or, being a Dutchman, was eager to encourage the sale of an important article of his country's commerce, is not easy to say. On the other hand, the pernicious effects of tea upon the nervous system have been often repeated, and very opposite effects have been ascribed to it. Some affirm that green tea is mildly astringent; others say it is relaxing: Some say it is narcotic, and procures sleep; while others contend, that taken before bed-time it assuredly prevents it.

Dr Lettsom, who has written the Natural History of the Tea Tree, made several experiments to determine its chemical qualities. He found an infusion of it preserved beef fresh; it is therefore antiseptic; and from its striking a purple colour with the salt (sulphate) of iron, he justly concludes that it is astringent; and he thinks also, that the essential qualities of tea reside in its fragrant and volatile parts.

We have heard much of the bad effects of tea, but we have neither felt nor observed them. If it were so pernicious as it has been represented by some, its effects must certainly be evident in China, where it is drunk by all ranks; yet so far from being thought hurtful in that country, it is in high estimation. The present emperor has composed a kind of eloge on the virtues of tea. We are told by those who have written the history of China, that inflammatory diseases are less frequent there than in many other countries, which is ascribed solely to the liberal use of tea. It must be observed by all, that tea is an antidote against intemperance, and that he who relishes the one seldom runs into the other. Raynal says, that tea has contributed more to the sobriety of this nation than the severest laws, the most eloquent harangues of Christian orators, or the best treatises of morality. We have no doubt but it may be hurtful to some constitutions in particular circumstances; but we suspect that the nervous disorders so often attributed to tea, are rather owing to hereditary diseases, to want of exercise, and to irregularity in food or sleep, than to tea.

"Weak tea drunk too hot (says Dr Leake) will enervate, and if very strong, may prove equally pernicious by affecting the head or stomach. But when it is drunk in moderation, and not too warm, with a large addition of milk, I believe it will seldom prove hurtful, but, on the contrary, salutary. After study or fatigue it is a most refreshing and grateful repast; it quenches thirst, and cheers the spirits, without heating the blood; and the pleasing society, in which we so often partake of it is no inconsiderable addition to its value; for whatever affords rational pleasure to the mind, will always contribute to bodily health.

In this country teas are generally divided into three kinds of green, and five of bohea: The former are, 1. Imperial or bloom tea, with a large loose leaf, light green

(F) The numerous instances in 1817 and 1818, of dealers being convicted of selling spurious tea, show that the process of adulteration is carried on to a great extent in this country. Mr Twining, a considerable tea dealer in London, published a pamphlet some years ago, in which he has exposed this infamous traffic. The information (he says) was obtained from a gentleman who had made very accurate inquiries into this subject.

The smouch for mixing with black teas is made of the leaves of the ash. When gathered, they are first dried in the sun, then baked: they are next put upon a floor, and trod upon until the leaves are small, then sifted and steeped in copperas with sheep's dung; after which, being dried on a floor, they are fit for use. There is also another mode: When the leaves are gathered, they are boiled in a copper with copperas and sheep's dung; when the liquor is strained off, they are baked and trod upon, until the leaves are small, after which they are fit for use. The quantity manufactured at a small village, and within eight or ten miles thereof, cannot be ascertained, but is supposed to be about 20 tons in a year. One man acknowledges to have made 600 weight in every week for six months together. The fine is sold at 4l. 4s. per cwt. equal to 9d per lb. The coarse is sold at 2l. 2s. per cwt. equal to $4\frac{1}{2}$ per lb. Elder buds are manufactured in some places to represent fine teas.

For the honour of human nature, we hope such a traffic as this is not very common: but if it be, those concerned in it deserve exemplary punishment. The only way (Mr Twining says) to escape this adulterated tea, is never to purchase from those who offer their teas to sale at lower prices than genuine teas can be afforded; but to purchase them only from persons of character.

green colour, and a faint delicate smell. 2. Hyson, so called from the name of the merchant who first imported it; the leaves of which are closely curled and small, of a green colour, verging to a blue: And, 3. Singlo tea, from the name of the place where it is cultivated. The boheas are, 1. Souchong, which imparts a yellow green colour by infusion. 2. Cambo, so called from the place where it is made; a fragrant tea, with a violet smell; its infusion pale. 3. Congo, which has a larger leaf than the following, and its infusion somewhat deeper, resembling common bohea in the colour of the leaf. 4. Pekoe tea; this is known by the appearance of small white flowers mixed with it. 5. Common bohea, whose leaves are of one colour. There are other varieties, particularly a kind of green tea, done up in roundish balls, called *gunpowder-tea.*

Tea-Tree of New Zealand, is a species of myrtle, of which an infusion was drunk by Captain Cook's people in their voyages round the world. Its leaves were finely aromatic, astringent, and had a particular pleasant flavour at the first infusion; but this went off at the next filling up of the tea-pot, and a great degree of bitterness was then extracted; for which reason it was never suffered to be twice infused. In a fine soil in thick forests this tree grows to a considerable size; sometimes 30 or 40 feet in height, and one foot in diameter. On a hilly and dry exposure it degenerates into a shrub of five or six inches; but its usual size is about eight or ten feet high, and three inches in diameter. In that case its stem is irregular and unequal, dividing very soon into branches, which arise at acute angles, and only bear leaves and flowers at top. The flowers are white, and very ornamental to the whole plant.

Mr White, in his Journal of a Voyage to New South Wales, mentions a shrub which he calls a *tea-tree* merely from its being used by the convicts as a succedaneum for tea; for he had not seen the flower, nor did he know to what genus it belonged. It is a creeping kind of a vine, running to a great extent along the ground; the stalk slender; the leaf not so large as the common bay leaf; the taste sweet, exactly like the liquorice root of the shops.

TEACHERS, persons employed in conducting the education of the young.

We will venture to say, that there is no class of men to whom a nation is so much indebted as to those employed in instructing the young: For if it be education that forms the only distinction between the civilized and the savage, much certainly is due to those who devote themselves to the office of instruction. It must be the duty therefore of every state to take care that proper encouragement be given to those who undertake this office. There ought to be such a salary as would render it an object of ambition to men of abilities and learning, or at least as would keep the teacher respectable. In Scotland, the office of a schoolmaster was formerly much more lucrative than at present, and most of that class had received liberal education; and this is the reason why the common people in Scotland have been famous even to a proverb, for their learning. But at present the salary of a country schoolmaster, independent of fees for scholars, is not greater than a ploughman can earn, being seldom more than 8l. 6s. 8d. the consequence of which is that this, which is in fact an honourable, because an useful profession, is now sinking into contempt. It is no longer an object to a man of learning; and we must soon be satisfied with schoolmasters that can read, write, and cast accounts, a little better than the lowest of the people, or who from some natural deformity are unable to exercise a trade. And what in this case must become of the minds of the common people! They must be totally uncultivated.

We have observed a great difference between the cultivation of the common people in one part of Scotland compared with another; and we have found, that wherever a schoolmaster is looked upon as a mean profession there is scarcely a duly qualified person to be found to undertake the office; and in those places the common people are lamentably ignorant. In other places again, where the schoolmaster is considered as one of the principal persons in the parish, there men of a liberal education, young divines, and preachers, do not think themselves disgraced by exercising this profession; and there the common people show a degree of acuteness, knowledge, and observation, and possess such polished manners, as raise them very high above those of their own rank in other parts of the country.

Many and keen have been the debates about a reform of government of late years; but little attention has been paid to the formation of the minds of the common people, who constitute the greater part of the nation; of course they are ready to join the standard of every seditious demagogue who sounds the alarm of oppression; and should they at length be roused, their cruelty and barbarity, like the common people of France, would be exactly in proportion to their ignorance and want of principle.

We are willing to hope, then, that the government and the moneyed men of the nation, who alone have property to lose and money to bestow, will at length find it to be their interest to patronize schoolmasters.

TEAL. See ANAS, ORNITHOLOGY *Index.*

TEARS, a lymph or aqueous humour, which is limpid, and a little saltish: it is separated from the arterial blood by the lachrymal glands and small glandulous grains on the inside of the eyelids.

TEASELS, a plant cultivated in the west of England for the use of clothiers. See DIPSACUS, BOTANY *Index.*

TEBETH, the tenth month of the Jewish ecclesiastical year, and fourth of the civil. It answers to our month of December.

TECLENBURG, a town of Germany, in the circle of Westphalia, capital of a county of the same name, with a castle built on a hill. It was bought by the king of Prussia in 1707. E. Long. 8. 2. N. Lat. 52. 20.

TECHNICAL, expresses somewhat relating to arts or sciences: in this sense we say technical terms. It is also particularly applied to a kind of verses wherein are contained the rules or precepts of any art, thus digested to help the memory to retain them; an example whereof may be seen in the article MEMORY.

TECTONA, TEAK-WOOD, a genus of plants belonging to the class pentandria. See BOTANY, p. 139.

TE DEUM, the name of a celebrated hymn, used in the Christian church, and so called because it begins with these words, *Te Deum laudamus*, We praise thee, O God. It is sung in the Romish church with great pomp

pomp and solemnity upon the gaining of a victory, or other happy event; and is believed to be the composition of St AMBROSE bishop of *Milan*.

TEES, a river which rises on the confines of Cumberland, and running eastward, divides the county of Durham from Yorkshire, and falls into the German sea below Stockton.

TEETH, the bones placed in the jaws for chewing food, that it may be the more easily digested in the stomach. The anatomical structure of the teeth has already been described under ANATOMY. The diseases to which they are liable, as well as the most successful remedies for removing them, are fully detailed under MEDICINE and SURGERY.

Much attention has been paid to the beauty and preservation of the teeth among most nations. The Romans rubbed and washed them with great care; and when they lost them, supplied their place with artificial teeth made of ivory; and sometimes, when loose, bound them with gold. Ligatures of wire have been found to hurt the natural teeth with which the artificial are connected: whereas silken twist cannot affect them to any considerable degree for several years.

Guilleman gives us the composition of a paste for making artificial teeth, which shall never grow yellow: the composition is white wax granulated, and melted with a little gum elemi, adding powder of white mastich, coral, and pearl.

When several teeth are out in the same place, it is best to make a set, or the number wanted, out of one piece, all adhering together, which may be fastened to the two next of the sound or natural teeth. And even a whole set of artificial teeth may be made for one or both jaws, so well fitted to admit of the necessary motions, and so conveniently retained in the proper situation by means of springs, that they will answer every purpose of natural teeth, and may be taken out, cleaned, and replaced, by the patient himself with great ease.

The common trick of mountebanks and other such practitioners, is to use various washes for teeth, the sudden effects of which, in cleaning and whitening the teeth, surprise and please people; but the effects are very pernicious. All the strong acid spirits will do this. As good a mixture as any thing can be, on this occasion, is the following: take plantane-water an ounce, honey of roses two drams, muriatic acid ten drops; mix the whole together, and rub the teeth with a piece of linen rag dipped in this every day till they are whitened. The mouth ought to be well washed with cold water after the use of this or any other acid liquor; and indeed the best of all teeth washes is cold water, with or without a little salt; the constant use of this will keep them clean and white, and prevent them from aching.

After all the numerous cures which have been proposed for preventing the toothach, we will venture to recommend the keeping the teeth clean as the most efficacious, and avoiding every kind of hot food, especially hot liquids, as tea, &c. They who are constantly using powders generally destroy their teeth altogether, as the valetudinarian does his health.

TEETHING in children. See MEDICINE.

TEFF, a kind of grain, sown all over Abyssinia, from which is made the bread commonly used throughout the country. We have no description of this plant but from Mr Bruce, who says that it is herbaceous; and that from a number of weak leaves surrounding the root proceeds a stalk of about 28 inches in length, not perfectly straight, smooth, but jointed or knotted at particular distances. This stalk is not much thicker than that of a carnation or julyflower. About eight inches from the top, a head is formed of a number of small branches, upon which it carries the fruit and flowers; the latter of which is small, of a crimson colour, and scarcely perceptible by the naked eye but from the opposition of that colour. The pistil is divided into two, seemingly attached to the germ of the fruit, and has at each end small capillaments forming a brush. The stamina are three in number; two on the lower side of the pistil, and one on the upper. These are each of them crowned with two oval stigmata, at first green, but after crimson. The fruit is formed in a capsula, consisting of two conical hollow leaves, which, when closed, seems to compose a small conical pod, pointed at the top. The fruit or seed is oblong, and is not so large as the head of the smallest pin; yet it is very prolific, and produces these seeds in such quantity as to yield a very abundant crop in the quantity of meal.

Our author, from the similarity of the names, conjectures it to be the *tipha* mentioned, but not described, by Pliny; but this conjecture, which he acknowledges to be unsupported, is of very little importance.

There are three kinds of meal made from teff, of which the best (he says) is as white as flour, exceedingly light, and easily digested; the second is of a browner colour; and the last, which is the food of soldiers and servants, is nearly black. This variety he imagines to arise entirely from the difference of soils in which the seeds are sown, and the different degrees of moisture to which the plant is exposed when growing. The manner of making the meal or flour into bread is by taking a broad earthen jar, and having made a lump of it with water, they put it into an earthen jar at some distance from the fire, where it remains till it begins to ferment or turn sour; they then bake it into cakes of a circular form, and about two feet in diameter: it is of a spungy soft quality, and not a disagreeable sourish taste. Two of these cakes a-day, and a coarse cotton cloth once a year, are the wages of a common servant.

At their banquets of raw meat, the flesh being cut in small bits, is wrapt up in pieces of this bread, with a proportion of fossil salt and Cayenne pepper. Before the company sits down to eat, a number of these cakes of different qualities are placed one upon the other, in the same manner as our plates, and the principal people sitting first down, eat the white teff; the second or coarser sort serves the second-rate people that succeed them, and the third is for the servants. Every man, when he is done, dries or wipes his fingers upon the bread which he is to leave for his successor, for they have no towels; and this is one of the most beastly customs among them.

Of this teff bread the natives makes a liquor, by a process which our author describes in the following words. The bread, when well toasted, is broken into small pieces, which are put into a large jar, and have warm water poured upon them. It is then set by the fire, and frequently stirred for several days, the mouth of the jar being close covered. After being allowed to settle three or four days, it acquires a sourish taste, and is what they call *bouza*, or the common beer of the country. The bouza in Atbara is made in the same manner, only instead

stead of teff, cakes of barley meal are employed. Both are very bad liquors, but the worst is that made of barley.

TEFFLIS, or TIFFLIS, a town of Asia, in Georgia, one of the seven nations between the Black sea and the Caspian. It is the capital of that country, the place of residence of its sovereign, and is called by the inhabitants *Thilis-Cabar*, "warm town," from the warm baths in its neighbourhood. Though its circumference does not exceed two English miles, it contains 20,000 inhabitants, of which more than half are Armenians; the remainder are principally Georgians, with some Tartars. According to Major Rennel, it has 20 Armenian and 15 Greek churches, and three metsheds. But Mr Coxe, on the authority of Professor Guldenstaedt, states the places of worship to be one Roman Catholic, 13 Greek, and seven Armenian churches. There are some magnificent caravanseras, bazars, and palaces in the city, but no mosques; for the Georgians, though living under a Mohammedan government, have always risen up in arms as often as any attempts have been made to erect such places of Mohammedan worship. Many of the Romish missionaries live here in disguise under the denomination of physicians, surgeons, and chemists; and the great cures which they perform procure them much esteem, though they are sometimes exposed to the insults of the people when they attempt to make any proselytes to their church. All the houses are of stone, with flat roofs, which serve, according to the customs of the East, as walks for the women. They are neatly built; the rooms are wainscotted, and the floors spread with carpets. The streets seldom exceed seven feet in breadth; and some are so narrow as scarcely to allow room for a man on horseback: they are consequently very filthy.

Tefflis is a place of considerable trade, especially in furs, which are conveyed hence to Constantinople by the way of Erzerum. As for the silks of this country, they are bought up on the spot by the Armenians, and conveyed to Smyrna and other ports of the Mediterranean; but the greatest part is first sent to Erzerum to be manufactured, the Georgians being very ignorant and unskilful in that respect. From hence, likewise, great quantities of a root called *boya* is sent to Erzerum and Indostan for the use of the linen dyers. Here is likewise a foundery, at which are cast a few cannon, mortars, and balls, all of which are very inferior to those of the Turks. The gunpowder made here is very good. The Armenians have likewise established in this town all the manufactures carried on by their countrymen in Persia: the most flourishing is that of printed linens. Tefflis is seated on the river Kur, at the foot of a mountain; and on the south side of it stands a large castle or fortress, built by the Turks in 1576, when they made themselves masters of the city and country, under the command of the famous Mustapha Pacha. It is 125 miles west of Terki. E. Long. 63. 3. N. Lat. 41. 59.

TEGERHY, a principal town in Fezzan, in Africa, about 80 miles south-west of the capital. It collects from its lands little other produce than dates and Indian corn. In this, as in every town in Fezzan, a market for butcher-meat, corn, fruit, and vegetables, is regularly held. Mutton and goats flesh are sold by the quarter without weighing; the usual price is from 32 to 40 grains of gold-dust, or four or five shillings English money. The flesh of the camel, which is much more highly valued, is commonly sold at a dearer rate, and is divided into smaller lots. Agriculture and pasturage seem to be the principal occupations.

TEGUMENT, any thing that surrounds or covers another.

TEIND, in *Scots Law*. See LAW, N° clxx.

Commission of TEINDS. See COMMISSION.

TEINTS and SEMITEINTS, in *Painting*, denote the several colours used in a picture, considered as more or less high, bright, deep, thin, or weakened and diminished, &c. to give the proper relievo, softness, or distance &c. of the several objects.

TELEGRAPH (derived from τηλε and γραφω), is the name very properly given to an instrument, by means of which information may be almost instantaneously conveyed to a considerable distance.

The telegraph, though it has been generally known and used by the moderns only for a few years, is by no means a modern invention. There is reason to believe that amongst the Greeks there was some sort of telegraph in use. The burning of Troy was certainly known in Greece very soon after it happened, and before any person had returned from thence. Now that was altogether so tedious a piece of business, that conjecture never could have supplied the place of information. A Greek play begins with a scene, in which a watchman descends from the top of a tower in Greece, and gives the information that Troy was taken. "I have been looking out these ten years (says he) to see when that would happen, and this night it is done." Of the antiquity of a mode of conveying intelligence quickly to a great distance, this is certainly a proof.

The Chinese, when they send couriers on the great canal, or when any great man travels there, make signals by fire from one day's journey to another, to have every thing prepared; and most of the barbarous nations used formerly to give the alarm of war by fires lighted on the hills or rising grounds.

Polybius calls the different instruments used by the ancients for communicating information πυρσιαι, *pyrsiæ*, because the signals were always made by means of fire. At first they communicated information of events merely by torches; but this method was of little use, because it was necessary before-hand to fix the meaning of every particular signal. Now as events are exceedingly various, it was impossible to express the greater number of them by any premeditated contrivance. It was easy, for instance, to express by signals that a fleet had arrived at such a place, because this had been foreseen, and signals accordingly had been agreed upon to denote it; but an unexpected revolt, a murder, and such accidents, as happen but too often, and require an immediate remedy, could not be communicated by such signals; because to foresee them was impossible.

Æneas, a contemporary of Aristotle, who wrote a treatise on the duties of a general, endeavoured to correct those imperfections, but by no means succeeded. "Those (says he) who would give signals to one another upon affairs of importance, must first prepare two vessels of earth, exactly equal in breadth and depth; and they need be but four feet and a half deep, and a foot and a half wide. They then must take pieces of cork, proportioned to the mouth of these vessels, but not quite so wide, that they may be let down with ease to the bottom of these vessels. They next fix in the middle of this

Polybius, book x. chap. 43.

TELEGRAPH.

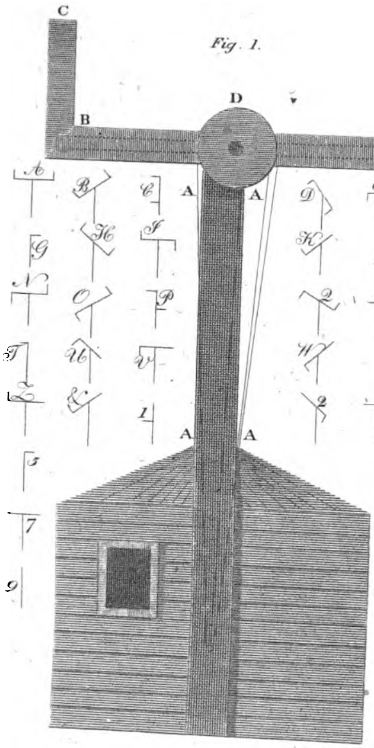


Fig. 2.

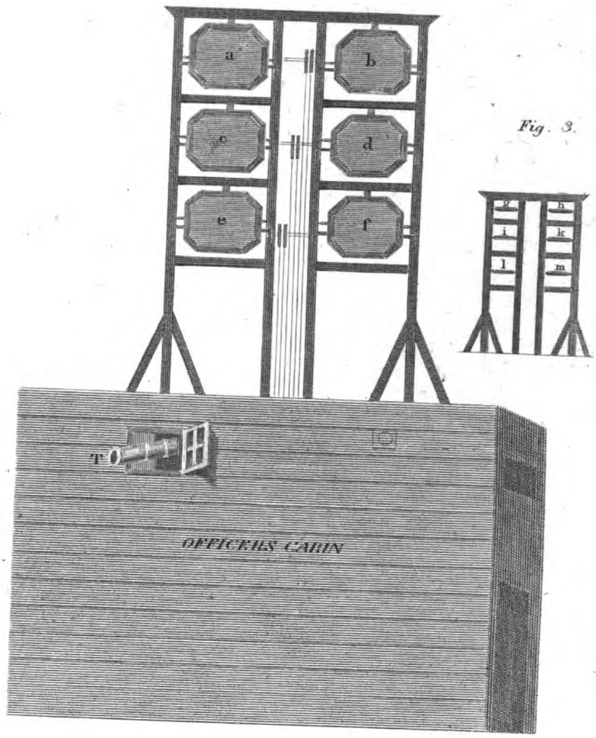


Fig. 3.

TELESCOPE.

Fig. 1.

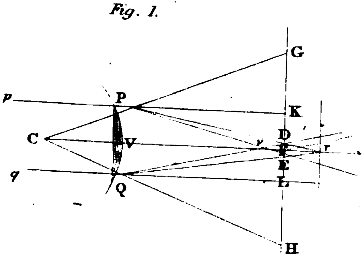


Fig. 3.

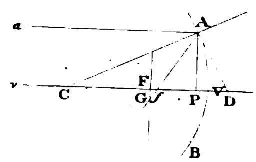


Fig. 4.

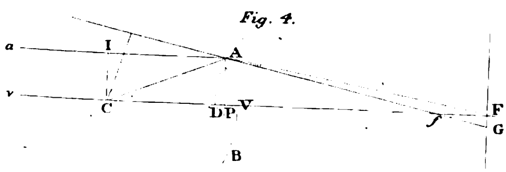


Fig. 5.

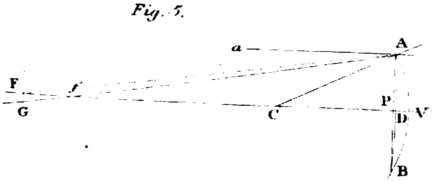
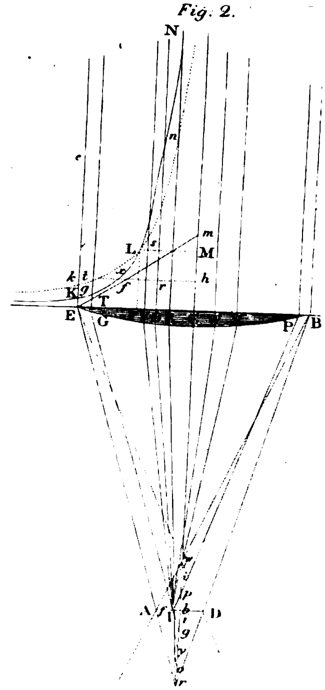


Fig. 2.



E. Mitchell Sculp.

this cork a stick, which must be of equal size in both these vessels. This stick must be divided exactly and distinctly, by spaces of three inches each, in order that such events as generally happen in war may be written on them. For example, on one of these spaces the following words may be written: 'A BODY OF HORSE ARE MARCHED INTO THE COUNTRY.' On another, 'A BODY OF INFANTRY, heavily armed, are arrived hither.' On a third, 'INFANTRY LIGHTLY ARMED.' On a fourth, 'HORSE AND FOOT.' On another, 'SHIPS;' then 'PROVISIONS;' and so on till all the events which may probably happen in the war that is carrying on are marked in these intervals.

This being done, each of the two vessels must have a little tube or cock of equal bigness, to let out the water in equal proportion. Then the two vessels must be filled with water; the pieces of cork, with their sticks thrust through them, must be laid upon them, and the cocks must be opened. Now, it is plain, that as these vessels are equal, the corks will sink, and the sticks descend lower in the vessels, in proportion as they empty themselves. But to be more certain of this exactness, it will be proper to make the experiment first, and to examine whether all things correspond and agree together, by an uniform execution on both sides. When they are well assured of this, the two vessels must be carried to the two places where the signals are to be made and observed: water is poured in, and the corks and sticks are put in the vessels. When any of the events which are written on the sticks shall happen, a torch or other light is raised, which must be held aloft till such time as another is raised by the party to whom it is directed. (This first signal is only to give notice that both parties are ready and attentive). Then the torch or other light must be taken away, and the cocks set open. When the interval, that is that part of the stick where the event of which notice is to be given or written, shall be fallen to a level with the vessels, then the man who gives the signal lifts up his torch; and on the other side, the correspondent signal-maker immediately turns the cock of his vessel, and looks at what is writ on that part of the stick which touches the mouth of the vessel: on which occasion, if every thing has been executed exactly and equally on both sides, both will read the same thing."

This method was defective, because it could not convey any other intelligence except what was written on the sticks, and even that not particularly enough. With regard to all unforeseen events, it was quite useless.

Polybius. ibid.

A new method was invented by Cleoxenus (others say by Democlitus), and very much improved by Polybius, as he himself informs us. He describes this method as follows: Take the letters of the (Greek) alphabet, and divide them into five parts, each of which will consist of five letters, except the last division, which will have only four. Let these be fixed on a board in five columns. The man who is to give the signals is then to begin by holding up two torches, which he is to keep aloft till the other party has also shown two. This is only to show that both sides are ready. These first torches are then withdrawn. Both parties are provided with boards, on which the letters are disposed as formerly described. The person who then gives the signal is to hold up torches on the left to point out to the other party from what column he shall take the letters as they are pointed out to him. If it is to be from the first column, he holds up one torch; if from the second, two; and so on for the others. He is then to hold up torches on the right, to denote the particular letter of the column that is to be taken. All this must have been agreed on before-hand. The man who gives the signals must have an instrument (διοπτραν), consisting of two tubes, and so placed as that, by looking through one of them, he can see only the right side, and through the other only the left, of him who is to answer. The board must be set up near this instrument; and the station on the right and left must be surrounded with a wall (παραπεφραχθαι) ten feet broad, and about the height of a man, that the torches raised above it may give a clear and strong light, and that when taken down they may be completely concealed. Let us now suppose that this information is to be communicated,—*A number of the auxiliaries, about a hundred, have gone over to the enemy.* In the first place, words must be chosen that will convey the information in the fewest letters possible: as, *A hundred Cretans have deserted,* Κρητες εκατον αφ' ημων ηυτομολησαν. Having written down this sentence, it is conveyed in this manner. The first letter is a κ, which is in the second column; two torches are therefore to be raised on the left hand to inform the person who receives the signals to look into that particular column. Then five torches are to be held up on the right, to mark the letter *k*, which is the last in the column. Then four torches are to be held up on the left to point out the ρ (*r*), which is in the fourth column, and two on the right to show that it is the second letter of that column. The other letters are pointed out in the same manner. —Such was the *pyrsia* or telegraph recommended by Polybius.

But neither this nor any other method mentioned by the ancients seems ever to have been brought into general use; nor does it appear that the moderns had thought of such a machine as a *telegraph* till the year 1663, when the Marquis of Worcester, in his CENTURY OF INVENTIONS, affirmed that he had discovered "a method by which, at a window, as far as eye can discover black from white, a man may hold discourse with his correspondent, without noise made or notice taken; being according to occasion given, or means afforded, *ex re nata*, and no need of provision before hand; though much better if foreseen, and course taken by mutual consent of parties." This could be done only by means of a telegraph, which in the next sentence is declared to have been rendered so perfect, that by means of it the correspondence could be carried on "by night as well as by day, though as dark as pitch is black."

About 40 years afterwards M. Amontons proposed a new telegraph. His method was this: Let there be people placed in several stations, at such a distance from one another, that by the help of a telescope a man in one station may see a signal made in the next before him; he must immediately make the same signal, that it may be seen by persons in the station next after him, who are to communicate it to those in the following station, and so on. These signals may be as letters of the alphabet, or as a cipher, understood only by the two persons who are in the distant places, and not by those who make the signals. The person in the second station making the signal to the person in the third the very moment he sees it in the first, the news may be carried to the greatest

Telegraph.

distance in as little time as is necessary to make the signals in the first station. The distance of the several stations, which must be as few as possible, is measured by the reach of a telescope. Amontons tried this method in a small tract of land before several persons of the highest rank at the court of France.

It was not, however, till the French revolution that the telegraph was applied to useful purposes. Whether M. Chappe, who is said to have invented the telegraph first used by the French about the end of 1793, knew any thing of Amontons's invention or not, it is impossible to say; but his telegraph was constructed on principles nearly similar. The manner of using this telegraph was as follows. At the first station, which was on the roof of the palace of the Louvre at Paris, M. Chappe, the inventor, received in writing, from the committee of public welfare, the words to be sent to Lisle, near which the French army at that time was. An upright post was erected on the Louvre, at the top of which were two transverse arms, moveable in all directions by a single piece of mechanism, and with inconceivable rapidity. He invented a number of positions for these arms, which stood as signs for the letters of the alphabet; and these, for the greater celerity and simplicity, he reduced in number as much as possible. The grammarian will easily conceive that sixteen signs may amply supply all the letters of the alphabet, since some letters may be omitted not only without detriment but with advantage. These signs, as they were arbitrary, could be changed every week; so that the sign of B for one day might be the sign of M the next; and it was only necessary that the persons at the extremity should know the key. The intermediate operators were only instructed generally in these sixteen signals; which were so distinct, so marked, so different the one from the other, that they were easily remembered. The construction of the machine was such, that each signal was uniformly given in precisely the same manner at all times: It did not depend on the operator's manual skill; and the position of the arm could never, for any one signal, be a degree higher or a degree lower, its movement being regulated mechanically.

M. Chappe having received at the Louvre the sentence to be conveyed, gave a known signal to the second station, which was Mont Martre, to prepare. At each station there was a watch tower, where telescopes were fixed, and the person on watch gave the signal of preparation which he had received, and this communicated successively through all the line, which brought them all into a state of readiness. The person at Mont Martre then received, letter by letter, the sentence from the Louvre, which he repeated with his own machine; and this was again repeated from the next height, with inconceivable rapidity, to the final station at Lisle.

English Review, June 1796.

The first description of the telegraph was brought from Paris to Frankfort on the Maine by a former member of the parliament of Bourdeaux, who had seen that which was erected on the mountain of Belville. As given by Dr Hutton from some of the English papers, it is as follows. AA is a beam or mast of wood placed upright on a rising ground (fig. 1.), which is about 15 or 16 feet high. BB is a beam or balance moving upon the centre AA. This balance-beam may be placed vertically or horizontally, or any how inclined, by means of strong cords, which are fixed to the wheel D, on the edge of which is a double groove to receive the two cords. This balance is about 11 or 12 feet long, and nine inches broad, having at the ends two pieces of wood CC, which likewise turn upon angles by means of four other cords that pass through the axis of the main balance, otherwise the balance would derange the cords; the pieces C are each about three feet long, and may be placed either to the right or left, straight, or square, with the balance-beam. By means of these three the combination or movement is very extensive, remarkably simple, and easily performed. Below is a small wooden gouge or hut, in which a person is employed to observe the movements of the machine. In the mountain nearest to this another person is to repeat these movements, and a third to write them down. The time taken up for each movement is 20 seconds; of which the motion alone is four seconds, the other 16 the machine is stationary. Two working models of this instrument were executed at Frankfort, and sent by Mr W. Playfair to the duke of York; and hence the plan and alphabet of the machine came to England.

Plate DXXVIII. fig. 1.

Various experiments were in consequence tried upon telegraphs in this country; and one was soon after set up by government in a chain of stations from the admiralty-office to the sea coast. It consists of six octagon boards, each of which is poised upon an axis in a frame, in such a manner that it can be either placed vertically, so as to appear with its full size to the observer at the nearest station, as in fig. 2. or it becomes invisible to him by being placed horizontally, as in fig. 3. so that the narrow edge alone is exposed, which narrow edge is from a distance invisible. Fig. 2. is a representation of this telegraph, with the parts all shut, and the machine ready to work. T, in the officer's cabin, is the telescope pointed to the next station. Fig. 3. is a representation of the machine not at work, and with the ports all open. The opening of the first port (fig. 2.) expresses *a*, the second *b*, the third *c*, the fourth *d*, the fifth *e*, the sixth *f*, &c.

Fig. 2.

Fig. 3.

Six boards make 36 changes, by the most plain and simple mode of working; and they will make many more if more were necessary: but as the real superiority of the telegraph over all other modes of making signals consists in its making letters, we do not think that more changes than the letters of the alphabet, and the ten arithmetical ciphers, are necessary; but, on the contrary, that those who work the telegraphs should avoid communicating by words or signs agreed upon to express sentences; for that is the sure method never to become expert at sending unexpected intelligence accurately.

This telegraph is without doubt made up of the best number of combinations possible; five boards would be insufficient, and seven would be useless. It has been objected to it, however, that its form is too clumsy to admit of its being raised to any considerable height above the building on which it stands; and that it cannot be made to change its direction, and consequently cannot be seen but from one particular point.

Several other telegraphs have been proposed to remedy these defects, and perhaps others to which the instrument is still liable. The dial-plate of a clock would make an excellent telegraph, as it might exhibit 144 signs so as to be visible at a great distance. A telegraph on this principle, with only six divisions instead of twelve, Telegraph.

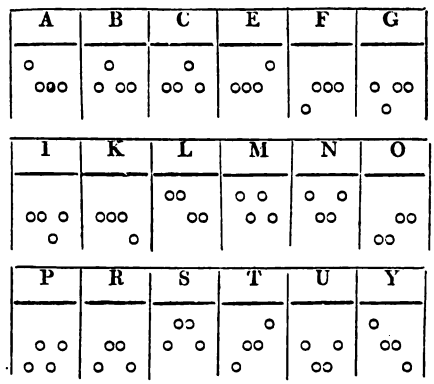
twelve, would be simple and cheap, and might be raised 20 or 30 feet high above the building, without any difficulty: it might be supported on one post, and therefore turn round, and the contrast of colours would always be the same.

Supplement for 1794.

A very ingenious improvement of the telegraph has been proposed in the Gentleman's Magazine. It consists of a semicircle, to be properly elevated, and fixed perpendicularly on a strong stand. The radius 12 feet; the semicircle consequently somewhat more than 36. This to be divided into 24 parts. Each of these will therefore comprise a space of 18 inches, and an arch of $7^{\circ} 30'$ on the circumference. These 24 divisions to be occupied by as many circular apertures of six inches diameter; which will leave a clear space of six inches on each side between the apertures. These apertures, beginning from the left, to denote the letters of the alphabet, omitting K, J consonant, V, X, and Q, as useless for this purpose. There are then 21 letters. The four other spaces are reserved for signals. The instrument to have an index moveable by a windlass on the centre of the semicircle, and having two tops, according as it is to be used in the day or night; one, a circular top of lacquered iron or copper, of equal diameter with the apertures (and which consequently will eclipse any of them against which it rests); the other, a spear or arrow-shaped top, black and highly polished, which, in standing before any of the apertures in the day-time, will be distinctly visible. In the night, the apertures to be reduced by a diaphragm fitting close to each, so as to leave an aperture of not more than two inches diameter. The diaphragm to be of well-polished tin; the inner rim lacquered black half an inch. All the apertures to be illuminated, when the instrument is used in the night-time, by small lamps; to which, if necessary, according to circumstances, convex lenses may be added, fitted into each diaphragm, by which the light may be powerfully concentrated and increased. Over each aperture one of the five prismatic colours least likely to be mistaken (the remaining two being less distinguishable, and not wanted, are best omitted) to be painted; and, in their natural order, on a width of eighteen inches and a depth of four, red, orange, yellow, green, blue; or, still to heighten the contrast, and render immediately successive apertures more distinguishable, red, green, orange, blue, yellow. The whole inner circle beneath and between the apertures to be painted black.

When the instrument is to be used, the index to be set to the signal apertures on the right. All the apertures to be covered or dark when it begins to be used, except that which is to give the signal. A signal gun to be fired to apprise the observer. If the index is set to the first aperture, it will denote that words are to be expressed; if to the second, that figures; if to the third, that the figures cease; and that the intelligence is carried on in words. When figures are to be expressed, the alternate apertures from the left are taken in their order, to denote from 1 to 10 inclusively; the second from the right denotes 100; the fifth 1000. This order, and these intervals, are taken to prevent any confusion in so peculiarly important an article of the intelligence to be conveyed.

Perhaps, however, none of the telegraphs hitherto offered to the public exceeds the following, either in simplicity, cheapness, or facility in working, and it might perhaps, with a few trifling additions, be made exceedingly distinct. It is thus described in the Repertory of Arts and Manufactures: For a nocturnal telegraph, let there be four large patent reflectors, lying on the same plane, parallel to the horizon, placed on the top of an observatory. Let each of these reflectors be capable, by means of two winches, either of elevation or depression to a certain degree. By elevating or depressing one or two of the reflectors, eighteen very distinct arrangements may be produced, as the following scheme will explain (A).



For the sake of example, the above arrangements are made to answer to the most necessary letters of the alphabet; but alterations may be made at will, and a greater number of changes produced, without any addition to the reflectors. In the first observatory there need only be a set of *single* reflectors; but in the others each reflector should be double, so as to face both the preceding and subsequent observatory; and each observatory should be furnished with two telescopes. The proper diameter of the reflectors, and their distance from each other, will be ascertained by experience.

To convert this machine into a diurnal telegraph, nothing more is necessary than to insert, in the place of the reflectors, gilt balls, or any other conspicuous bodies.

Were telegraphs brought to so great a degree of perfection, that they could convey information speedily and distinctly; were they so much simplified, that they could be constructed and maintained at little expence—the advantages which would result from their use are almost inconceivable. Not to speak of the speed with which information could be communicated and orders given in time of war, by means of which misfortunes might be prevented or instantly repaired, difficulties removed, and disputes precluded, and by means of which the whole kingdom could be prepared in an instant to oppose an invading

(A) Each reflector, after every arrangement, must be restored to its place.

invading enemy; it might be used by commercial men to convey a commission cheaper and speedier than an express can travel. The capitals of distant nations might be united by chains of posts, and the settling of those disputes which at present take up months or years might then be accomplished in as many hours. An establishment of telegraphs might then be made like that of the post; and instead of being an expence, it would produce a revenue. Until telegraphs are employed to convey information that occurs very frequently, the persons who are stationed to work them will never become expert, and consequently will neither be expeditious nor accurate, though, with practice, there is no doubt but they will attain both in a degree of perfection of which we can as yet have but little conception.

Various other improvements of the telegraph might have been mentioned, but our limits do not permit us to dwell longer on the subject.

TELEMACHUS, the son of Ulysses and Penelope, was still in the cradle when his father went with the rest of the Greeks to the Trojan war. At the end of this celebrated war, Telemachus, anxious to see his father, went to seek him; and as the place of his residence, and the cause of his long absence, were then unknown, he visited the court of Menelaus and Nestor to obtain information. He afterwards returned to Ithaca, where the suitors of his mother Penelope had conspired to murder him, but he avoided their snares; and by means of Minerva he discovered his father, who had arrived in the island two days before him, and was then in the house of Eumæus. With this faithful servant and Ulysses Telemachus concerted how to deliver his mother from the importunities of her suitors, and it was effected with great success. After the death of his father, Telemachus went to the island of Ææa, where he married Circe, or, according to others, Cassiphone the daughter of Circe, by whom he had a son called *Latinus*. He some time after had the misfortune to kill his mother-in-law Circe, and fled to Italy, where he founded Clusium. Telemachus was accompanied in his visit to Nestor and Menelaus by the goddess of wisdom under the form of Mentor. It is said that, when a child, Telemachus fell into the sea, and that a dolphin brought him safe to shore, after he had remained some time under water. From this circumstance Ulysses had the figure of a dolphin engraved on the seal which he wore on his ring.

From these stories, collected from Homer and the other poets of antiquity, the celebrated Fenelon, archbishop of Cambray, took the idea of his well-known *Adventures of Telemachus*; which, though not composed in verse, is justly intitled to be esteemed a poem. "The plan of the work (says Dr Blair) is in general well contrived; and is deficient neither in epic grandeur nor unity of object. The author has entered with much felicity into the spirit and ideas of the ancient poets, particularly into the ancient mythology, which retains more dignity, and makes a better figure in his hands than in those of any other modern poet. His descriptions are rich and beautiful; especially of the softer and calmer scenes, for which the genius of Fenelon was best suited; such as the incidents of pastoral life, the pleasures of virtue, or a country flourishing in peace. There is an inimitable sweetness and tenderness in several of the pictures of this kind which he has given;" and his measured prose, which is remarkably harmonious, gives the style nearly as much elevation as the French language is capable of supporting even in regular verse.

Lectures on Rhetoric and the Belles Lettres.

According to the same eminent critic, "the best executed part of the work is the first six books, in which Telemachus recounts his adventures to Calypso. The narration throughout them is lively and interesting. Afterwards, especially in the last 12 books, it becomes more tedious and languid; and in the warlike adventures which are attempted, there is a great defect of vigour. The chief objection against this work being classed with epic poems, arises from the minute details of virtuous policy, into which the author in some places enters; and from the discourses and instructions of Mentor, which recur upon us too often, and too much in the strain of common-place morality. Though these were well suited to the main design of the author, which was to form the mind of a young prince, yet they seem not congruous to the nature of epic poetry; the object of which is to improve us by means of actions, characters, and sentiments, rather than by delivering professed and formal instruction."

TELEPHIUM, True Orpine, a genus of plants belonging to the class pentandria; and in the natural system ranging under the 54th order, *Miscellaneæ*. See Botany *Index*.

TELESCOPE, an optical instrument for viewing distant objects; so named by compounding the Greek words τηλε, *far off*, and σκοπεω, *I look at* or *contemplate*. This name is commonly appropriated to the larger sizes of the instrument, while the smaller are called PERSPECTIVE-GLASSES, SPY-GLASSES, OPERA-GLASSES. A particular kind, which is thought to be much brighter than the rest, is called a NIGHT-GLASS.

To what has been said already with respect to the inventor of this most noble and useful instrument in the article Optics, we may add the two following claims.

Mr Leonhard Digges, a gentleman of the 17th century of great and various knowledge, positively asserts in his *Stratioticos*, and in another work, that his father, a military gentleman, had an instrument which he used in the field, by which he could bring distant objects near, and could know a man at the distance of three miles. He says, that when his father was at home he had often looked through it, and could distinguish the waving of the trees on the opposite side of the Severn. Mr Digges resided in the neighbourhood of Bristol.

Francis Fontana, in his *Celestial Observations*, published at Naples in 1646, says, that he was assured by a Mr Hardy, advocate of the parliament of Paris, a person of great learning and undoubted integrity, that on the death of his father, there was found among his things an old tube, by which distant objects were distinctly seen; and that it was of a date long prior to the telescope lately invented, and had been kept by him as a secret.

It is not all improbable, that curious people, handling spectacle glasses, of which there were by this time great varieties, both convex and concave, and amusing themselves with their magnifying power and the singular effects which they produced in the appearances of things, might sometimes chance so to place them as to produce distinct and enlarged vision. We know perfectly, from the table and scheme which Sirturus has given us of the tools or dishes in which the spectacle-makers

Telescope. makers fashioned their glasses, that they had convex lenses formed to spheres of 24 inches diameter, and of 11 inferior sizes. He has given us a scheme of a set which he got leave to measure, belonging to a spectacle-maker of the name of *Rogette* at Corunna in Spain; and he says that this man had tools of the same sizes for concave glasses. It also appears, that it was a general practice (of which we do not know the precise purpose) to use a convex and concave glass together. If any person should chance to put together a 24-inch convex and a 12-inch concave (wrought on both sides) at the distance of six inches, he would have distinct vision, and the object would appear of double size. Concaves of six inches were not uncommon, and one such combined with the convex of 24, at the distance of nine inches, would have distinct vision, and objects would be quadrupled in diameter. When such a thing occurred, it was natural to keep it as a curiosity, although the *rationale* of its operation was not in the least understood. We doubt not but that this happened much oftener than in these two instances. The chief wonder is, that it was not frequent, and taken notice of by some writer. It is pretty plain that Galileo's first telescope was of this kind, made up of such spectacle-glasses as he could procure; for it magnified only three times in diameter; a thing easily procured by such glasses as he could find with every spectacle-maker. And he could not but observe, in his trials of their glasses, that the deeper concaves and flatter convexes he employed, he produced the greater amplification; and then he would find himself obliged to provide a tool not used by the spectacle-makers, viz. either a much flatter tool for a convex surface, or a much smaller sphere for a concave; and, notwithstanding his telling us that it was by reflecting on the nature of refraction, and without any instruction, we are persuaded that he proceeded in this very way. His next telescope magnified but five times. Now the slightest acquaintance with the obvious laws of refraction would have directed him at once to a very small and deep concave, which would have been much easier made, and have magnified more. But he groped his way with such spectacle-glasses as he could get, till he at last made tools for very flat object-glasses and very deep eye-glasses, and produced a telescope which magnified about 25 times. Sirturus saw it, and took the measures of it. He afterwards saw a scheme of it which Galileo had sent to a German prince at Inspruck, who had it drawn (that is, the circles for the tools) on a table in his gallery. The object-glass was a plano-convex, a portion of a sphere of 24 inches diameter; the eye-glass was a double concave of two inches diameter; the focal distances were therefore 24 inches and one inch nearly. This must have been a very lucky operation, for Sirturus says it was the best telescope he had seen: and we know that it requires the very best work to produce this magnifying power with such small spheres. Telescopes continued to be made in this way for many years; and Galileo, though keenly engaged in the observation of Jupiter's satellites, being candidate for the prize held out by the Dutch for the discovery of the longitude, and therefore much interested in the advantage which a convex eye-glass would have given him, never made them of any other form. Kepler published his Dioptrics in 1611; in which he tells us, all that he or others had discovered of the law of refraction, viz. that in very small obliquities of incidence, the angle of refraction was nearly one-third of the angle of incidence. This was indeed enough to have pointed out, with sufficient exactness, the construction of every optical instrument that we are even now possessed of; for this proportionality of the angles of incidence and refraction is assumed in the construction of the optical figure for all of them; and the deviation from it is still considered as the *refinement* of the art, and was not brought to any rule till 50 years after by Huyghens, and called by him ABERRATION. Yet even the sagacious Kepler seems not to have seen the advantage of any other construction of the telescope; he just seems to acknowledge the possibility of it: and we are surprised to see writers giving him as the author of the astronomical telescope, or even as hinting at its construction. It is true, in the last proposition he shows how a telescope may be made *apparently* with a convex eye-glass: but this is only a frivolous fancy; for the eye-glass is directed to be made convex externally, and a very deep concave on the inside; so that it is, in fact, a meniscus with the concavity prevalent. In the 86th proposition, he indeed shows that it is possible so to place a convex glass behind another convex glass, that an eye shall see objects distinct, magnified, and inverted; and he speaks very sagaciously on the subject. After having said that an eye placed behind the point of union of the first glass will see an object inverted, he shows that a small part only will be seen; and then he shows that a convex glass, duly proportioned and properly placed, will show more of it. But in showing this, he speaks in a way which shows evidently that he had formed no distinct notions of the manner in which this effect would be produced, only saying vaguely that the convergency of the second glass would counteract the divergency beyond the focus of the first. Had he conceived the matter with any tolerable distinctness, after seeing the great advantage of taking in a field greater in almost any proportion, he would have eagerly catched at the thought, and enlarged on the immense improvement. Had he but drawn one figure of the progress of the rays through two convex glasses, the whole would have been open to his view.

This step, so easy and so important, was reserved for Father Scheiner, as has been already observed in the article OPTICS; and the construction of this author, together with that of Jansen, are the models on which all refracting telescopes are now constructed; and in all that relates to their magnifying power, brightness, and field of vision, they may be constructed on Kepler's principle, that the angles of refraction are in a certain given proportion to the angles of incidence.

But after Huyghens had applied his elegant geometry to the discovery of Snellius, viz. the proportionality, not of the angles, but of the sines, and had ascertained the aberrations from the foci of infinitely slender pencils, the reasons were clearly pointed out why there were such narrow limits affixed by nature to the performance of optical instruments, in consequence of the indistinctness of vision which resulted from constructions where the magnifying power, the quantity of light, or the field of vision, were extended beyond certain moderate bounds. The theory of aberrations, which that most excellent geometer established, has enabled us to diminish this indistinctness arising from any of these causes; and this diminution

Telescope. diminution is the sole aim of all the different constructions which have been contrived since the days of Galileo and Scheiner.

The description which has been already given of the various constructions of telescopes in the article Optics, is sufficient for instructing the reader in the general principles of their construction, and with moderate attention will show the manner in which the rays of light proceed, in order to ensure the different circumstances of amplification, brightness, and extent of field, and even distinctness of vision, in as far as depends on the proper intervals between the glasses. But it is insufficient for giving us a knowledge of the improvements which are aimed at in the different departures from the original constructions of Galileo and Scheiner, the advantage of the double eye-glass of Huyghens, and the quintuple eye-glass of Dolland: still more is it insufficient for showing us why the highest degrees of amplification and most extensive field cannot be obtained by the mere proportion of the focal distances of the glasses, as Kepler had taught. In short, without the Huyghenian doctrine of aberrations, neither can the curious reader learn the limits of their performance, nor the artist learn why one telescope is better than another, or in what manner to proceed to make a telescope differing in any particular from those which he servilely copies.

Although all the improvements in the construction of telescopes since the publication of Huyghen's Dioptrics have been the productions of this island, and although Dr Smith of Cambridge has given the most elegant and perspicuous account of this science that has yet appeared, we do not recollect a performance in the English language (except the Optics of Emerson) which will carry the reader beyond the mere schoolboy elements of the science, or enable a person of mathematical skill to understand or improve the construction of optical instruments. The last work on this subject of any extent (Dr Priestley's History of Vision) is merely a parlour book for the amusement of half-taught dilettanti, but is totally deficient in the mathematical part, although it is here that the science of optics has her chief claim to pre-eminence, and to the name of a DISCIPLINA ACCURATA. But this would have been *ultra crepidam;* and the author would in all probability have made as poor a figure here as he has done in his attempts to degrade his species in his Commentaries on the *Vibratiunculæ* of Hartley; motions which neither the author nor his amplificator were able to understand or explain. We trust that our readers, jealous as we are of every thing that sinks us in the scale of nature's works, will pardon this transient ejaculation of spleen, when our thoughts are called to a system which, of *absolute and unavoidable necessity*, makes the DIVINE MIND nothing but a quivering of *that matter* of which it is the AUTHOR and unerring DIRECTOR. *Sed missum faciamus.*

We think therefore that we shall do the public some service, by giving such an account of this *higher branch* of optical science as will at least tend to the complete understanding of this noble instrument, by which our conceptions of the extent of almighty power, and wisdom, and beneficence, are so wonderfully enlarged. In the prosecution of this we hope that many general rules will emerge, by which artists who are not mathematicians may be enabled to construct optical instruments with intelligence, and avoid the many blunders and defects which result from mere servile imitation.

The general aim in the construction of a telescope is, to form, by means of mirrors or lenses, an image of the distant object, as large, as bright, and as extensive as is possible, consistently with distinctness; and then to view the image with a magnifying glass in any convenient manner. This gives us an arrangement of our subject. We shall first show the principles of construction of the object-glass or mirror, so as that it shall form an image of the distant object with these qualities; and then show how to construct the magnifying glass or eye-piece, so as to preserve them unimpaired.

This indistinctness which we wish to avoid arises from two causes; the spherical figures of the refracting and reflecting surfaces, and the different refrangibility of the differently coloured rays of light. The first may be called the SPHERICAL and the second the CHROMATIC indistinctness; and the deviations from the foci, determined by an elementary theorem, given under Optics, may be called the SPHERICAL and the CHROMATIC aberrations.

The limits of a work like this will not permit us to give any more of the doctrine of aberrations than is absolutely necessary for the construction of achromatic telescopes; and we must refer the reader for a general view of the whole to Euler's *Dioptrics*, and other works of that kind. Dr Smith has given as much as was necessary for the comparison of the merits of different glasses of similar construction, and this in a very plain and elegant manner.

We shall begin with the aberration of colour, because it is the most simple.

Let white or compounded light fall perpendicularly on the flat side PQ (fig. 1.) of a plano-convex lens PVQ, whose axis is CV and vertex V. The white ray p P falling on the extremity of the lens is dispersed by refraction at the point P of the spherical surface, and the red ray goes to the point r of the axis, and the violet ray to the point v. In like manner the white ray q Q is dispersed by refraction at Q, the red ray going to r, and the violet to v. The red ray P r crosses the violet ray Q v in a point D, and Q r crosses P v in a point E; and the whole light refracted and dispersed by the circumference whose diameter is PQ, passes through the circular area, whose diameter is DE. Supposing that the lens is of such a form that it would collect red rays, refracted by its whole surface in the point r, and violet in the point v; then it is evident that the whole light which occupies the surface of the lens will pass through this little circle, whose diameter is DE. Therefore white light issuing from a point so distant that the rays may be considered as parallel, will not be collected in another point or focus, but will be dispersed over the surface of that little circle: which is therefore called the *circle of chromatic dispersion;* and the radiant point will be represented by this circle. The neighbouring points are in like manner represented by circles; and these circles encroaching on and mixing with each other, must occasion haziness or confusion, and render the picture indistinct. This indistinctness will be greater in the proportion of the number of circles which are in this manner mixed together. This will be in the proportion of the room that is for them; that is, in proportion to the area of the circle, or in the duplicate proportion

Plate DXXVI I. fig. 1.

tion of its diameter. Our first business therefore is, to obtain measures of this diameter, and to mark the connection between it and the aperture and focal distance of the lens.

Let i be to r as the sine of incidence in glass to the sine of refraction of the red rays; and let i be to v as the sine of incidence to the sine of refraction of the violet rays. Then we say, that when the aperture PQ is moderate, $v-r : v+r-2i = \text{DE} : \text{PQ}$, very nearly. For let DE, which is evidently perpendicular to V r, meet the parallel incident rays in K and L and the radii of the spherical surface in G and H. It is plain that GPK is equal to the angle of incidence on the posterior or spherical surface of the lens; and GP r and GP v are the angles of the refraction of the red and the violet rays; and that GK, GD, and GE, are very nearly as the sines of those angles, because the angles are supposed to be small. We may therefore institute this proportion $\text{DE} : \text{KD} = v-r : r-i$; then, by doubling the consequents $\text{DE} : 2\,\text{KD} = v-r : 2r-2i$. Also $\text{DE} : 2\,\text{KD} + \text{DE} = v-r : 2r-2i+v-r, = v-r : r+v-2i$. But $2\,\text{KD} + \text{DE}$ is equal to KL or PQ. Therefore we have $\text{DE} : \text{PQ} = v-r : r+v-2i$. *Q. E. D.*

Cor. 1. Sir Isaac Newton, by most accurate observation, found, that in common glass the sines of refraction of the red and violet rays were 77 and 78 where the sine of incidence was 50. Hence it follows, that $v-r$ is to $v+n-2i$ as 1 to 55; and that the diameter of the smallest circle of dispersion is $\frac{1}{55}$th part of that of the lens.

2. In like manner may be determined the circle of dispersion that will comprehend the rays of any particular colour or set of colours. Thus all the orange and yellow will pass through a circle whose diameter is $\frac{1}{250}$th of that of the lens.

3. In different surfaces, or plano-convex lenses, the angles of aberration r P v are as the breadth PQ directly, and as the focal distance VF inversely; because any angle DPE is as its subtense DE directly and radius DP inversely. N. B. We call VF the focal distance, because at this distance, or at the point F, the light is most of all constipated. If we examine the focal distance by holding the lens to the sun, we judge it to be where the light is drawn into the smallest spot.

When we reflect that a lens of $5\frac{1}{2}$ inches in diameter has a circle of dispersion $\frac{1}{10}$th of an inch in diameter, we are surprised that it produces any picture of an object that can be distinguished. We should not expect greater distinctness from such a lens than would be produced in a camera obscura without a lens, by simply admitting the light through a hole of $\frac{1}{10}$th of an inch in diameter. This, we know, would be very hazy and confused. But when we remark the superior vivacity of the yellow and orange light in comparison with the rest, we may believe that the effect produced by the confusion of the other colours will be much less sensible. But a stronger reason is, that the light is much denser in the middle of the circle of dispersion, and is exceedingly faint towards the margin. This, however, must not be taken for granted; and we must know distinctly the manner in which the light of different colours is distributed over the circle of chromatic dispersion, before we pretend to pronounce on the immense difference between the indistinctness arising from colour and that arising from the spherical figure. We think this the more necessary, because the illustrious discoverer of the chromatic aberration has made a great mistake in the comparison, because he did not consider the distribution of the light in the circle of spherical dispersion. It is therefore proper to investigate the chromatic distribution of the light with the same care that we bestowed on the spherical dispersion in Optics, and we shall then see that the superiority of the reflecting telescope is incomparably less than Newton imagined it to be.

Therefore let EB (fig. 2.) represent a plano-convex lens, of which C is the centre and C r the axis. Let us suppose it to have no spherical aberration, but to collect rays occupying its whole surface to single points in the axis. Let a beam of white or compounded light fall perpendicularly on its plane surface. The rays will be so refracted by its curved surface, that the extreme red rays will be collected at r, the extreme violet rays at w, and those of intermediate refrangibility at intermediate points, o, y, g, b, p, v, of the line rw, which is nearly $\frac{1}{28}$th of rC. The extreme red and violet rays will cross each other at A and D; and AD will be a section or diameter of the circle of chromatic dispersion, and will be about $\frac{1}{55}$th of EB. We may suppose wr to be bisected in b, because wb is to br very nearly in the ratio of equality (for $rb : r\text{C} = b\text{A} : c\text{E}, = b\text{A} : c\text{B}, = wb : w\text{C}$). The line rw will be a kind of prismatic spectrum, red from r to o, orange-coloured from o to y, yellow from y to g, green from g to b, blue from b to p, purple from p to v, and violet from v to w. Fig. 2.

The light in its compound state must be supposed uniformly dense as it falls upon the lens; and the same must be said of the rays of any particular colour. Newton supposes also, that when a white ray, such as c E, is dispersed into its component coloured rays by refraction at E, it is uniformly spread over the angle DEA. This supposition is indeed gratuitous; but we have no argument to the contrary, and may therefore consider it as just. The consequence is, that each point w, v, p, b, &c. of the spectrum is not only equally luminous, but also illuminates uniformly its corresponding portion of AD: that is to say, the coating (so to term it) of any particular colour, such as purple, from the point p, is uniformly dense in every part of AD on which it falls. In like manner, the colouring of yellow, intercepted by a part of AD in its passage to the point y, is uniformly dense in all its parts. But the density of the different colours in AD is extremely different: for since the radiation in w is equally dense with that in p, the density of the violet colouring, which radiates from w, and is spread over the whole of AD, must be much less than the density of the purple colouring, which radiates from p, and occupies only a part of AD round the circle b. These densities must be very nearly in the inverse proportion of $w\,b^2$ to $p\,b^2$.

Hence we see, that the central point b will be very intensely illuminated by the blue radiating from $p\,b$ and the green intercepted from $b\,g$. It will be more faintly illuminated by the purple radiating from $v\,p$, and the yellow intercepted from $g\,y$; and still more faintly by the violet from $w\,v$, and the orange and red intercepted from $y\,r$. The whole colouring will be a white, tending a little to yellowness. The accurate proportion of these

these colourings may be computed from our knowledge of the position of the points $o, y, g,$ &c. But this is of little moment. It is of more consequence to be able to determine the proportion of the total intensity of the light in b to its intensity in any other point I.

For this purpose draw r IR, I w W, meeting the lens in R and W. The point I receives none of the light which passes through the space RW: for it is evident that b I : CR$=b$ A : CE, $=1:55$, and that CR$=$CW; and therefore, since all the light incident on EB passes through AB, all the light incident on RW passes through I i ($b\,i$ being made$=b$ I). Draw o IO, y IY, g IG, I p P, I v V. It is plain that I receives red light from RO, orange from OY, yellow from YG, green from GE, a little blue from BP, purple from PV, and violet from VW. It therefore wants some of the green and of the blue.

That we may judge of the intensity of these colours at I, suppose the lens covered with paper pierced with a small hole at G. The green light only will pass through I; the other colours will pass between I and b, or between I and A, according as they are more or less refrangible than the particular green at I. This particular colour converges to g, and therefore will illuminate a small spot round I, where it will be as much denser than it is at G as this spot is smaller than the hole at G. The natural density at G, therefore, will be to the increased density at I, as $g\,\mathrm{I}^2$ to $g\,\mathrm{G}^2$, or as $g\,b^2$ to $g\,\mathrm{C}^2$, or as $b\,\mathrm{I}^2$ to CG^2. In like manner, the natural density of the purple coming to I through an equal hole at P will be to the increased density at I as $b\,\mathrm{I}^2$ to CP^2. And thus it appears, that the intensity of the differently coloured illuminations of *any* point of the circle of dispersion, is inversely proportional to the square of the distance from the centre of the lens to the point of its surface through which the colouring light comes to this point of the circle of dispersion. This circumstance will give us a very easy, and, we think, an elegant solution of the question.

Bisect CE in F, and draw FL perpendicular to CE, making it equal to CF. Through the point L describe the hyperbola KLN of the second order, that is, having the ordinates EK, FL, RN, &c. inversely proportional to the squares of the abscissæ CE, CF, CR, &c.; so that $\mathrm{FL}:\mathrm{RN}=\frac{1}{\mathrm{CF}^2}:\frac{1}{\mathrm{CR}^2}$, or $=\mathrm{CR}^2:\mathrm{CF}^2$, &c. It is evident that these ordinates are proportional to the densities of the severally coloured lights which go from them to any points whatever of the circle of dispersion.

Now the total density of the light at I depends both on the density of each particular colour and on the number of colours which fall on it. The ordinates of this hyperbola determine the first; and the space ER measures the number of colours which fall on I, because it receives light from the whole of ER, and of its equal BW. Therefore, if ordinates be drawn from any point of ER, their sum will be as the whole light which goes to I; that is, the total density of the light at I will be proportional to the area NREK. Now it is known that CE$\times$EK is equal to the infinitely extended area lying beyond EK; and CR$\times$RN is equal to the infinitely extended area lying beyond RN. Therefore the area NREK is equal to CR$\times$RN$-$CE$\times$EK. But RN and EK are respectively equal to $\frac{\mathrm{CF}^3}{\mathrm{CR}^2}$ and $\frac{\mathrm{CF}^3}{\mathrm{CE}^2}$. Therefore the density at I is proportional to $\mathrm{CF}^3\times\left(\frac{\mathrm{CR}}{\mathrm{CR}^2}-\frac{\mathrm{CE}}{\mathrm{CE}^2}\right), =\mathrm{CF}^3\times\left(\frac{1}{\mathrm{CR}}-\frac{1}{\mathrm{CE}}\right), =\mathrm{CF}^3\times\frac{\mathrm{CE}-\mathrm{CR}}{\mathrm{CE}\times\mathrm{CR}}$ $=\mathrm{CF}^3\times\frac{\mathrm{ER}}{\mathrm{CE}\times\mathrm{CR}}, =\frac{\mathrm{CF}^3}{\mathrm{CE}}\times\frac{\mathrm{ER}}{\mathrm{CR}}.$ But because CF is $\frac{1}{2}$ of CE, $\frac{\mathrm{CF}^3}{\mathrm{CE}}$ is $=\frac{\mathrm{CF}^3}{2\,\mathrm{CF}}, =\frac{\mathrm{CF}^2}{2}$, a constant quantity. Therefore the density of the light at I is proportional to $\frac{\mathrm{ER}}{\mathrm{CR}}$, or to $\frac{\mathrm{AI}}{b\,\mathrm{I}}$, because the points R and I are similarly situated in EC and A b.

Farther, if the semiaperture CE of the lens be called 1, $\frac{\mathrm{CF}^2}{2}$ is $=\frac{1}{8}$, and the density at I is $=\frac{\mathrm{AI}}{8\,b\,\mathrm{I}}$.

Here it is proper to observe, that since the point R has the same situation in the diameter EB that the point I has in the diameter AD of the circle of dispersion, the circle described on EB may be conceived as the magnified representation of the circle of dispersion. The point F, for instance, represents the point f in the circle of dispersion, which bisects the radius b A; and f receives no light from any part of the lens which is nearer the centre than F, being illuminated only by the light which comes through EF and its opposite BF′. The same may be said of every other point.

In like manner, the density of the light in f, the middle between b and A, is measured by $\frac{\mathrm{EF}}{\mathrm{CF}}$, which is $=\frac{\mathrm{EF}}{\mathrm{EF}}$, or 1. This makes the density at this point a proper standard of comparison. The density there is to the density at I as 1 to $\frac{\mathrm{AI}}{b\,\mathrm{I}}$, or as b I to AI; and this is the simplest mode of comparison. The density half way from the centre of the circle of dispersion is to the density at any point I as b I to AI.

Lastly, through L describe the common rectangular hyperbola k L n, meeting the ordinates of the former in k, L, and n: and draw $k\,h$ parallel to EC, cutting the ordinates in $g, f, r,$ &c. Then CR : CE$=$E k : R n, and CR : CE$-$CR$=$E k : R $n-$E k, or CR : RE$=$E k : $r\,n$, and b 1 : IA$=$E k : $r\,n$. And thus we have a very simple expression of the density in any point of the circle of dispersion. Let the point be anywhere, as at I. Divide the lens in R as AD is divided in I, and then $r\,n$ is as the density in I.

These two measures were given by Newton; the first in his *Treatise de Mundi Systemate*, and the last in his *Optics*, but both without demonstration.

If the hyperbola k L n be made to revolve round the axis CQ, it will generate a solid spindle, which will measure the whole quantity of light which passes through different portions of the circle of dispersion. Thus the solid produced by the revolution of L $k\,f$ will measure all the light which occupies the outer part of the circle of dispersion lying without the middle of the radius. This space is $\frac{3}{4}$ths of the whole circle; but the quantity of light is but $\frac{1}{4}$th of the whole.

A

Telescope.

A full more simple expression of the whole quantity of light passing through different portions of the circle of chromatic dispersion may now be obtained as follows:

It has been demonstrated, that the density of the light at I is as $\frac{\text{AI}}{b\,\text{I}}$, or as $\frac{\text{ER}}{\text{CR}}$. Suppose the figure to turn round the axis. I or R describe circumferences of circles; and the whole light passing through this circumference is as the circumference, or as the radius, and as the density jointly. It is therefore as $\frac{\text{ER}}{\text{CR}} \times \text{CR}$, that is, as ER. Draw any straight line E m, cutting RN in s, and any other ordinate FL in x R s. The whole light which illuminates the circumference described by I is to the whole light which illuminates the centre b as ER to EC, or as R s to C m. In like manner, the whole light which illuminates the circumference described by the point f in the circle of dispersion is to the whole light which illuminates the centre b, as F x to C m. The lines C m, RS, F x, are therefore proportional to the whole light which illuminates the corresponding circumferences in the circle of dispersion. Therefore the whole light which falls on the circle whose radius is b I, will be represented by the trapezium in CRS; and the whole light which falls on the ring described by IA, will be represented by the triangle E s R; and so of any other portions.

By considering the figure, we see that the distribution of the light is exceedingly unequal. Round the margin it has no sensible density; while its density in the very centre is incomparably greater than in any other point, being expressed by the asymptote of a hyperbola. Also the circle described with the radius $\frac{\text{A}\,b}{2}$ contains $\frac{1}{4}$ths of the whole light. No wonder then that the confusion caused by the mixture of these circles of dispersion is less than one should expect; besides, it is evident that the most lively or impressive colours occupy the middle of the spectrum, and are there much denser than the rest. The margin is covered with an illumination of deep red and violet, neither of which colours are brilliant. The margin will be of a dark claret colour. The centre revives all the colours, but in a proportion of intensity greatly different from that in the common prismatic spectrum, because the radiant points L, p, b, g, &c. by which it is illuminated, are at such different distances from it. It will be white; but we apprehend not a pure white, being greatly overcharged with the middle colours.

These considerations show that the coloured fringes which are observed to border very luminous objects seen on a dark ground through optical instruments, do not proceed from the object-glass of a telescope or microscope, but from an improper construction of the eye-glasses. The chromatic dispersion would produce fringes of a different colour, when they produce any at all, and the colours would be differently disposed. But this dispersion by the object-glass can hardly produce any fringes: its effect is a general and almost uniform mixture of circles all over the field, which produces an uniform haziness, as if the object were viewed at an improper distance, or out of its focus, as we vulgarly express it.

We may at present form a good guess at the limit which this cause puts to the performance of a telescope. A point of a very distant object is represented, in the picture formed by the object-glass, by a little circle, whose diameter is at least $\frac{1}{100}$th of the aperture of the object-glass, making a very full allowance for the superior brilliancy and density of the central light. We look at this picture with a magnifying eye-glass. This magnifies the picture of the point. If it amplify it to such a degree as to make it an object individually distinguishable, the confusion is then sensible. Now this can be computed. An object subtending one minute of a degree is distinguished by the dullest eye, even although it be a dark object on a bright ground. Let us therefore suppose a telescope, the object glass of which is of six feet focal distance, and one inch aperture. The diameter of the circle of chromatic dispersion will be $\frac{1}{100}$th of an inch, which subtends at the centre of the object-glass an angle of about $9\frac{1}{2}$ seconds. This, when magnified six times by an eye-glass, would become a distinguishable object; and a telescope of this length would be indistinct if it magnified more than six times, if a point were thus spread out into a spot of uniform intensity. But the spot is much less intense about its margin. It is found experimentally that a piece of engraving, having fine cross hatches, is not sensibly indistinct till brought so far from the limits of perfectly distinct vision, that this indistinctness amounts to 6′ or 5′ in breadth.—Therefore such a telescope will be sensibly distinct when it magnifies 36 times; and this is very agreeable to experience.

We come, in the second place, to the more arduous task of ascertaining the error arising from the spherical figure of the surfaces employed in optical instruments.—Suffice it to say, before we begin, that although geometers have exhibited other forms of lenses which are totally exempt from this error, they cannot be executed by the artist; and we are therefore restricted to the employment of spherical surfaces.

Of all the determinations which have been given of spherical aberration, that by Dr Smith, in his Optics, which is an improvement of the fundamental theorem of that most elegant geometer Huyghens, is the most perspicuous and palpable. Some others are more concise, and much better fitted for after use, and will therefore be employed by us in the prosecution of this article. But they do not keep in view the optical facts, giving the mind a picture of the progress of the rays which it can contemplate and discover amidst many modifying circumstances. By ingenious substitutions of analytical symbols, the investigation is rendered expeditious, concise, and certain; but these are not immediate symbols of things, but of operations of the mind; objects sufficiently subtle of themselves, and having no need of substitutions to make us lose sight of the real subject; and thus our occupation degenerates into a process almost without ideas. We shall therefore set out with Dr Smith's fundamental Theorem.

1. *In Reflections.*

Let AVB (fig. 3.) be a concave spherical mirror, of which C is the centre, V the vertex, CV the axis, and F the focus of an infinitely slender pencil of parallel rays passing Fig. 3.

Telescope. passing through the centre. Let the ray a A, parallel to the axis, be reflected in AG, crossing the central ray CV in f. Let AP be the sine of the semi-aperture AV, AD its tangent, and CD its secant.

The aberration Ff from the principal focus of central rays is equal to $\frac{1}{2}$ of the excess VD of the secant above the radius, or very near equal to $\frac{1}{2}$ of VP, the versed sine of the semi-aperture.

For because AD is perpendicular to CA, the points C, A, D, are in a circle, of which CD is the diameter; and because Af is equal to Cf, by reason of the equality of the angles fAC, fCA, and CA a, f is the centre of the circle through C, A, D, and fD is $= \frac{1}{2}$ CD. But FC is $= \frac{1}{2}$ CV. Therefore Ff is $\frac{1}{2}$ of VD.

But because DV : VP = DC : VC, and DC is very little greater than VC when the aperture AB is moderate, DV is very little greater than VP, and Ff is very nearly equal to $\frac{1}{2}$ of VP.

Cor. 1. The longitudinal abberration is $= \frac{AV^2}{4CV}$, for PV is very nearly $= \frac{AV^2}{2CV}$.

Cor. 2. The lateral aberration FG is $= \frac{AV^3}{2CV^2}$. For FG : Ff = AP : Pf, = AV : $\frac{1}{2}$ CV nearly, and therefore FG $= \frac{AV^2}{4CV} \times \frac{2}{CV} = \frac{AV^3}{2CV^2}$.

2. *In Refractions.*

Fig. 4. or 5. Let AVB (fig. 4. or 5.) be a spherical surface separating two refracting substances, C the centre, V the vertex, AV the semi-aperture, AP its sine, PV its versed sine, and F the focus of parallel rays infinitely near to the axis. Let the extreme ray a A, parallel to the axis, be refracted into AG, crossing CF in f, which is therefore the focus of extreme parallel rays.

The rectangle of the sine of incidence, by the difference of the sines of incidence and refraction, is to the square of the sine of refraction, as the versed sine of the semi-aperture is to the longitudinal aberration of the extreme rays.

Call the sine of incidence i, the sine of refraction r, and their difference d.

Join CA, and about the centre f describe the arch AD.

The angle ACV is equal to the angle of incidence, and CAf is the angle of refraction. Then, since the sine of incidence is to the sine of refraction as VF to CF, or as Af to Cf, that is, as Df to Cf, we have

CF : FV = Cf : fD
by conversion CF : CV = Cf : CD
altern. conver. CF—Cf : CV—CD=CF : CV
or Ff : VD=CF : CV, = r : d.

Now PV $= \frac{AP^2}{CP+CV}$, $= \frac{AP^2}{2CV}$ nearly, and PD $= \frac{AP^2}{fP+fV}$ $= \frac{AP^2}{2fV}$ nearly, $= \frac{AP^2}{2FV}$ nearly. Therefore PV : PD = FV : CV, and DV : PV=CF : FV nearly.

We had above Ff : VD=r : d;
and now - VD : PV=CF : FV, = r : i;
therefore - Ff : PV=r^2 : $d\,i$,

and F$f = \frac{r^2}{d\,i} \times$ PV. *Q. E. D.*

The aberration will be different according as the refraction is made towards or from the perpendicular; that is, according as r is less or greater than i. They are in the ratio of $\frac{r^2}{d\,i}$ to $\frac{i^2}{d\,r}$, or of r^3 to i^3. The aberration therefore is always much diminished when the refraction is made from a rare into a dense medium. The proportion of the sines for air and glass is nearly that of 3 to 2. When the light is refracted into the glass, the aberration is nearly $\frac{4}{9}$ of PV; and when the light passes out of glass into air, it is about $\frac{9}{2}$ of PV. Telescope.

Cor. 1. F$f = \frac{r^2}{d\,i} \times \frac{AP^2}{2CV}$ nearly, and it is also $= \frac{r^2}{d^2} \times \frac{AP^2}{2FV}$, because PV $= \frac{AP^2}{2CV}$ nearly, and $i : d =$ FV : CV.

Cor. 2. Because fP : PA=Ff : FG
or FV : AV=Ff : FG nearly,
we have FG, the lateral aberration, $=$ F$f \times \frac{AV}{FV}$, $= \frac{r^2}{d^2} \times \frac{AV^3}{2FV^2}$, $= \frac{r^2}{i^2} \times \frac{AV^3}{2CV^2}$.

Cor. 3. Because the angle FAf is proportional to $\frac{FG}{FV}$, very nearly, we have the angular aberration F A$f = \frac{r^2}{d^2} \times \frac{AV^3}{2FV^3} = \frac{r^2}{i^2} \times \frac{AV^3}{2CV^3}$.

In general, the longitudinal aberrations from the focus of central parallel rays are as the squares of the apertures directly, and as the focal distances inversely; and the lateral aberrations are as the cubes of the apertures directly, and the squares of the focal distances inversely; and the angular aberrations are as the cubes of the aperture directly, and the cubes of the focal distances inversely.

The reader must have observed, that to simplify the investigation, some small errors are admitted. PV and PD are not in the exact proportion that we assumed them, nor is Df equal to FV. But in the small apertures which suffice for optical instruments, these errors may be disregarded.

This spherical aberration produces an indistinctness of vision, in the same manner as the chromatic aberration does, viz. by spreading out every mathematical point of the object into a little spot in its picture; which spots, by mixing with each other, confuse the whole. We must now determine the diameter of the circle of diffusion, as we did in the case of chromatic dispersion.

Let a ray $\beta\,\alpha$ (fig. 6.) be refracted on the other side of the axis, into α H φ, cutting A f G in H, and draw the perpendicular EH. Call AV a, αV α, Vf (or VF, or V φ, which in this comparison may be taken as equal) $=f$, Ff=b, and fE=$\varphi\,x$. Plate DXXIX. fig. 6.

AV^2 : αV^2=Ff : F φ (already demonstrated) and Fφ $= \frac{\alpha^2}{a^2}b$, and Ff—Fφ, (or $f\varphi$) $= b - \frac{\alpha^2}{a^2}b, = \frac{a^2b-\alpha^2b}{a^2}$, $= \frac{b}{a^2} \times \overline{a^2-\alpha^2}, = \frac{b}{a^2} \times \overline{a+\alpha} \times \overline{a-\alpha}$. Also P$f$: PA =fE

$=f\text{E} : \text{EH}$, or $f : a = x : \frac{ax}{f}, = \text{EH}$. And $\text{P}\pi : \text{P}\varphi = \text{EH} : \text{E}\varphi$, or $\alpha : f = \frac{ax}{f} : \frac{ax}{\alpha}, = \text{E}\varphi$. Therefore $f\varphi = \frac{ax}{\alpha} + x, = \frac{\overline{a+\alpha}\,x}{\alpha}, = \frac{x}{\alpha} \times \overline{a+\alpha}$. Therefore $\frac{x}{a} \times \overline{a+\alpha} = \frac{b}{a^2} \times \overline{a+\alpha} \times \overline{a-\alpha}$, and $\frac{x}{a} = \frac{b}{a^2} \times \overline{a-\alpha}$, and $x = \frac{b}{a^2} \times \alpha(a-\alpha)$. Therefore x is greatest when $\alpha \times \overline{a-\alpha}$ is greatest; that is, when $\alpha = \frac{1}{2} a$. Therefore EH is greatest when $\text{P}\pi$ is equal to the half of AP. When this is the case, we have at the same time $\frac{b}{a^2} \times \alpha (a-\alpha) = \frac{b}{a^2} \times \frac{1}{4} a^2$, and $x = \frac{1}{4} b$, or $\text{EH} = \frac{1}{4}\text{FG}$. That is, the diameter of the circle of aberration through which the whole of the refracted light must pass, is $\frac{1}{4}$ of the diameter of the circle of aberration at the focus of parallel central rays. In the chromatic aberration it was $\frac{1}{2}$; so that in this respect the spherical aberration does not create so great confusion as the chromatic.

We are now able to compare them, since we have now the measure of both the circles of aberration.

It has not been found possible to give more than four inches of aperture to an object glass of 100 feet focal distance, so as to preserve sufficient distinctness. If we compute the diameter of the circle EH corresponding to this aperture, we shall find it not much to exceed $\frac{1}{120,000}$ of an inch. If we restrict the circle of chromatic dispersion to $\frac{1}{250}$ of the aperture, which is hardly the fifth part of the whole dispersion in it, it is $\frac{1}{62\frac{1}{2}}$ of an inch, and is about 1900 times greater than the other.

The circle of spherical aberration of a plano-convex lens, with the plane side next the distant object, is equal to the circle of chromatic dispersion when the semi-aperture is about 15°: For we saw formerly that EH is $\frac{1}{4}$ of FG, and that FG is $= \frac{r^2}{i^2}\,\frac{\text{AP}^3}{2\,\text{AC}^2}$, and therefore $\text{EG} = \frac{r^2}{i^2} \times \frac{\text{AP}^3}{8\,\text{AC}^2}$. This being made $= \frac{\text{AP}}{55}$, gives us $\text{AP} = \sqrt{\frac{8\,i^2\text{AC}^2}{53\,r^2}}$ which is nearly $\frac{\text{AC}}{4}$ and corresponds to an aperture of 30° diameter, if r be to i as 3 to 2.

Sir Isaac Newton was therefore well entitled to say, that it was quite needless to attempt figures which should have less aberration than spherical ones, while the confusion produced by the chromatic dispersion remained uncorrected. Since the indistinctness is as the squares of the diameters of the circles of aberration, the disproportion is quite beyond our imagination, even when Newton has made such a liberal allowance to the chromatic dispersion. But it must be acknowledged, that he has not attended to the distribution of the light in the circle of spherical aberration, and has hastily supposed it to be like the distribution of the coloured light, indefinitely rare in the margin, and denser in the centre.

We are indebted to Father Boscovich for the elegant determination of this distribution, which we have given in the article OPTICS. From this it appears, that the light in the margin of the circle of spherical aberration, instead of being incomparably rarer than in the spaces between it and the centre, is incomparably denser. The indistinctness therefore produced by the intersection of these luminous circumferences is vastly great, and increases the whole indistinctness exceedingly. By a gross calculation which we made, it appears to be increased at least 500 times. The proportional indistinctness therefore, instead of being 1900^2 to 1, is only $\frac{1900^2}{500}$, or nearly 7220 to 1; a proportion still sufficiently great to warrant Newton's preference of the reflecting telescope of his invention. And we may now observe, that the reflecting telescope has even a great advantage over a refracting one of the same focal distance, with respect to its spherical aberration: For we have seen (*Cor.* 2.) that the lateral aberration is $\frac{r^2}{i^2}\,\frac{\text{AV}^3}{2\,\text{CV}^2}$. This for a plano-convex glass is nearly $\frac{9}{4}\,\frac{\text{AV}^3}{2\,\text{CV}^2}$. And the diameter of the circle of aberration is one-fourth of this, or $\frac{9}{16} \times \frac{\text{AV}^3}{2\,\text{CV}^2}$. In like manner, the lateral aberration of a concave mirror is $\frac{\text{AV}^3}{2\,\text{CV}^2}$; and the diameter of the circle of dispersion is $\frac{\text{AV}^3}{8\,\text{CV}^2}$; and therefore if the surfaces were portions of the same sphere, the diameter of the circle of aberration of refracted rays would be to that of the circle of aberration of reflected rays as $\frac{9}{16}$ to $\frac{1}{4}$, or as 9 to 4. But when the refracting and reflecting surfaces, in the position here considered, have the same focal distance, the radius of the refracting surface is four times that of the reflecting surface. The proportion of the diameters of the circles of spherical aberration is that of 9×4^2 to 4, or of 144 to 4, or 36 to 1. The distinctness therefore of the reflector is 36×36, or 1296 times greater than that of a plano-convex lens (placed with the plane side next the distant object) of the same breadth and focal distance, and will therefore admit of a much greater magnifying power. This comparison is indeed made in circumstances most favourable to the reflector, because this is the very worst position of a plano-convex lens. But we have not as yet learned the aberration in any other position. In another position the refraction and consequent aberration of both surfaces are complicated.

Before we proceed to the consideration of this very difficult subject, we may deduce from what has been already demonstrated several general rules and maxims in the construction of telescopes, which will explain (to such readers as do not wish to enter more deeply into the subject), and justify the proportion which long practice of the best artists has sanctioned.

Indistinctness proceeds from the commixture of the circles of aberration on the retina of the eye: For any one *sensible* point of the retina, being the centre of a circle of aberration, will at once be affected by the admixture of the rays of as many different pencils of light as there are sensible points in the area of that circle, and will convey to the mind a mixed sensation of as many

 visible

visible points of the object. This number will be as the area of the circle of aberrations, whatever be the size of a sensible point of the retina. Now in vision with telescopes the diameter of the circle of aberration on the retina is as the *apparent* magnitude of the diameter of the corresponding circle in the focus of the eye-glass; that is, as the angle subtended by this diameter at the centre of the eye-glass; that is, as the diameter itself directly, and as the focal distance of the eye-glass inversely. And the area of that circle on the retina is as the area of the circle on the focus of the eye-glass directly, and as the square of the focal distance of the eye-glass inversely. And this is the measure of the apparent indistinctness.

Cor. In all sorts of telescopes, and also in compound microscopes, an object is seen equally distinct when the focal distances of the eye-glasses are proportional to the diameters of the circles of aberration in the focus of the object-glass.

Here we do not consider the trifling alteration which well constructed eye-glasses may add to the indistinctness of the first image.

In refracting telescopes, the apparent indistinctness is as the area of the object-glass directly, and as the square of the focal distance of the eye-glass inversely. For it has been shown, that the area of the circle of dispersion is as the area of the object-glass, and that the spherical aberration is insignificant when compared with this.

Therefore, to make reflecting telescopes equally distinct, the diameter of the object-glass must be proportional to the focal distance of the eye-glass.

But in reflecting telescopes, the indistinctness is as the sixth power of the aperture of the object-glass directly, and as the fourth power of the focal distance of the object-glass and square of the focal distance of the eye-glass inversely. This is evident from the dimensions of the circle of aberration, which was found proportional to $\frac{AV^3}{CV^2}$.

Therefore, to have them equally distinct, the cubes of the apertures must be proportional to the squares of the focal distance multiplied by the focal distance of the eye-glass.

By these rules, and a standard telescope of approved goodness, an artist can always proportion the parts of any instrument he wishes to construct. Mr Huyghens made one, of which the object-glass had 30 feet focal distance and three inches diameter. The eye-glass had 3.3 inches focal distances. And its performance was found superior to any which he had seen; nor did this appear owing to any chance goodness of the object-glass, because he found others equally good which were constructed on similar proportions. This has therefore been adopted as a standard,

It does not at first appear how there can be any difficulty in this matter, because we can always diminish the aperture of the object-glass or speculum till the circle of aberration is as small as we please. But by diminishing this aperture, we diminish the light in the duplicate ratio of the aperture. Whatever be the aperture, the brightness is diminished by the magnifying power, which spreads the light over a greater surface in the bottom of the eye. The apparent brightness must be as the square of the aperture of the telescope directly, and the square of the amplification of the diameter of an object inversely. Objects therefore will be seen equally bright if the apertures of the telescopes be as the focal distances of the object-glasses directly, and the focal distances of the single eyo-glass (or eye-glass equivalent to the eye-piece) inversely. Therefore, to have telescopes equally distinct and equally bright, we must combine these proportions with the former. It is needless to go farther into this subject, because the construction of refracting telescopes has been so materially changed by the correction of the chromatic aberration, that there can hardly be given any proportion between the object-glass and eye-glasses. Every thing now depends on the degree in which we can correct the aberrations of the object-glass. We have been able so far to diminish the chromatic aberration, that we can give very great apertures without its becoming sensible. But this is attended with so great an increase of the aberration of figure, that this last becomes a sensible quality. A lens which has 30° for its semi-aperture, has a circle of aberration equal to its chromatic aberration. Fortunately we can derive from the very method of contrary refractions, which we employ for removing the chromatic aberrations, a correction of the other. We are indebted for this contrivance also to the illustrious Newton.

We call this Newton's contrivance, because he was the first who proposed a construction of an object-glass in which the aberration was corrected by the contrary aberrations of glass and water.

Huyghens had indeed supposed, that our all-wise Creator had employed in the eyes of animals many refractions in place of one, in order to make the vision more distinct; and the invidious detractors from Newton's fame have catched at this vague conjecture as an indication of his knowledge of the possibility of destroying the aberration of figure by contrary refractions. But this is very ill-founded. Huyghens has acquired sufficient reputation by his theory of aberrations. The scope of his writing in the passage alluded to, is to show that, by dividing any intended refraction into parts, and producing a certain convergence to or divergence from the axis of an optical instrument by means of two or three lenses instead of one, we diminish the aberrations four or nine times. This conjecture about the eye was therefore in the natural train of his thoughts. But he did not think of destroying the aberration altogether by opposite refractions. Newton, in 1669, says that opticians need not trouble themselves about giving figures to their glasses other than spherical. If this figure were all the obstacle to the improvement of telescopes, he could show them a construction of an object-glass having spherical surfaces where the aberration is destroyed; and accordingly gives the construction of one composed of glass and water, in which this is done completely by means of contrary refractions.

The general principle is this: When the radiant point R (fig. 7.), or focus of incident rays, and its conjugate focus F of refracted central rays, are on opposite sides of the refracting surface or lens V, the conjugate focus f of marginal rays is nearer to R than F is. But when the focus of incident rays R′ lies on the same side with its conjugate focus F′ for central rays, R′f is greater than R′ F′. Fig. 7.

Now fig. 8. represents the contrivance for destroying the colour produced at F, the principal focus of the Fig. 8.

convex

Telescope. convex lens V, of crown glass, by means of the contrary refraction of the concave lens v of flint glass. The incident parallel rays are made to converge to F by the first lens. This convergence is diminished, but not entirely destroyed, by the concave lens v, and the focus is formed in F. F and F′ therefore are conjugate foci of the concave lens. If F be the focus of V for central rays, the marginal rays will be collected at some point f nearer to the lens. If F be now considered as the focus of light incident on the centre of v, and F′ be the conjugate focus, the marginal ray pF would be refracted to some point f' lying beyond F′. Therefore the marginal ray pf may be refracted to F, if the aberration of the concave be properly adjusted to that of the convex.

This brings us to the most difficult part of our subject, the compounded aberrations of different surfaces. Our limits will not give us room for treating this in the same elementary and perspicuous manner that we employed for a single surface. We must try to do it in a compendious way, which will admit at once the different surfaces and the different refractive powers of different substances. This must naturally render the process more complicated; but we hope to treat the subject in a way easily comprehended by any person moderately acquainted with common algebra; and we trust that our attempt will be favourably received by an indulgent public, as it is (as far as we know) the only dissertation in our language on the construction of achromatic instruments. We cannot but express our surprise at this indifference about an invention which has done so much honour to our country, and which now constitutes a very lucrative branch of its manufacture. Our artists infinitely surpass all the performances of foreigners in this branch, and supply the markets of Europe without any competition; yet it is from the writings on the continent that they derive their scientific instruction, and particularly from the dissertations of Clairaut, who has wonderfully simplified the analysis of optical propositions. We shall freely borrow from him, and from the writings of Abbé Boscovich, who has considerably improved the first views of Clairaut. We recommend the originals to the curious reader. Clairaut's dissertations are to be found in the Memoirs of the Academy of Paris, 1756, &c.; those of Boscovich in the Memoirs of the Academy of Bologna, and in his five volumes of *Opuscula*, published at Bassano in 1785. To these may be added D'Alembert and Euler. The only thing in our language is the translation of a very imperfect work by Schærfer.

Fig. 9. *Lemma* I. In the right-angled triangle MXS (fig. 9.), of which one side MX is very small in comparison of either of the others; the excess of the hypothenuse MS, above the side XS, is very nearly equal to $\frac{MX^2}{2MS}$ or to $\frac{MX^2}{2XS}$. For if about the centre S, with the radius SM, we describe the semicircle AMO, we have $AX \times XO = MX^2$. Now $AX = MS - SX$, and XO, is nearly equal to 2MS or 2XS; on the other hand, MS is nearly equal to $XS + \frac{MX^2}{2XS}$; and in like manner MG is nearly equal to $\frac{MX}{2XG} + XG$, and MH is nearly equal to $\frac{MX^2}{2XH} + XH$.

Prop. I. Let the ray m M, incident on the spherical surface AM, converge to G; that is, let G be the focus of incident rays. It is required to find the focus F of refracted rays?

Let m express the ratio of the sine of incidence and refraction; that is, let m be to 1 as the sine of incidence to the sine of refraction in the substance of the sphere.

Then - MG : GS = sin. MSH : sin. SMG,
and - m : 1 = sin. SMG : sin. SMH;
therefore . $m \times$ MG : GS = sin. MSH : sin. SMH.
Now S, MSH : S, SMH = MH : HS. Therefore, finally,
mMG : GS = MH : HS.

Now let MS, the radius of the refracting surface, be called a. Let AG, the distance of the focus of incident rays from the surface, be called r. And let AH, the focal distance of refracted rays, be called x. Lastly, let the sine MX of the semi-aperture be called e. Observe, too, that a, r, x, are to be considered as positive quantities, when AS, AG, AH, lie from the surface in the direction in which the light is supposed to move. If therefore the refracting surface be concave, that is, having the centre on that side from which the light comes; or if the incident rays are divergent, or the refracted rays are divergent; then a, r, x, are negative quantities.

It is plain that $HS = x - a$; $GS = r - a$; also $AX = \frac{e^2}{2a}$ nearly. $HX = a - \frac{e^2}{2a}$. $GX = r - \frac{e^2}{2a}$. Now add to HX and to GX their differences from MH and MG, which (by the Lemma) are $\frac{e^2}{2x}$ and $\frac{e^2}{2r}$. We get $MH = x - \frac{e^2}{2a} + \frac{e^2}{2x}$, and $MG = r - \frac{e^2}{2a} \times \frac{e^2}{2r}$. In order to shorten our notation, make $k = \frac{1}{a} - \frac{1}{r}$. This will make $MG = r - \frac{ke^2}{2}$.

Now substitute these values in the final analogy at the top of this column, viz. MH : HS = m.MG : GS; it becomes $x - \frac{e^2}{2a} + \frac{e^2}{2x} : x - a = mr - \frac{mke^2}{2} : r - a$ (or ark,) because $k = \frac{r-a}{ar}$, and $ark = r - a$. Now multiply the extreme and mean terms of this analogy. It is evident that it must give us an equation which will give us a value of x or AH, the quantity sought.

But this equation is quadratic. We may avoid the solution by an approximation which is sufficiently accurate, by substituting for x in the fraction $\frac{e^2}{2x}$ (which is very small in all cases of optical instruments), an approximate very easily obtained, and very near the truth. This is the focal distance of an infinitely slender pencil of rays converging to G. This we know by the common optical theorem to be $\frac{amr}{\overline{m-1}\,r \pm a}$. Let this be

called

called φ; if we substitute k in place of $\frac{1}{a}-\frac{1}{r}$, this value of φ becomes $=\frac{am}{m-ak}$.

This gives us, by the by, an easily remembered expression (and beautifully simple) of the refracted focus of an infinitely slender pencil, corresponding to any distance r of the radiant point. For since $\varphi=\frac{am}{m-ak}$, $\frac{1}{\varphi}$ must be $=\frac{m-ak}{am}, =\frac{m}{am}, -\frac{ak}{am}=\frac{1}{a}-\frac{k}{m}$. We may even express it more simply, by expanding k, and it becomes $\frac{1}{\varphi}=\frac{1}{a}-\frac{1}{ma}-\frac{1}{mr}$.

Now put this value of $\frac{1}{\varphi}$ in place of the $\frac{1}{x}$ in the analogy employed above. The first term of the analogy becomes $x-\frac{e^2}{2a}+\frac{e^2}{2a}-\frac{ke^2}{2m}$, or $x-\frac{ke^2}{2m}$. The analogy now becomes $x-\frac{ke^2}{2m}:xa=mr-\frac{mke^2}{2}:ark$. Hence we obtain the linear equation $mrx-\frac{mke^2x}{2}-mra+\frac{mkae^2}{2}=arkx-\frac{arke^2}{2m}$; from which we finally deduce

$$x=\frac{mra-\frac{1}{2}make^2-\frac{ark^2e^2}{2m}}{mr-ark-\frac{1}{2}mke}.$$

We may simplify this greatly by attending to the elementary theorem in fluxions, that the fraction $\frac{x+\dot{x}}{y+\dot{y}}$ differs from the fraction $\frac{x}{y}$ by the quantity $\frac{y\dot{x}-x\dot{y}}{y^2}$; this being the fluxion of $\frac{x}{y}$. Therefore $\frac{x+\dot{x}}{y+\dot{y}}=\frac{x}{y}+\frac{y\dot{x}-x\dot{y}}{y^2}$. Now the preceding formula is nearly in this situation. It may be written thus;

$$\frac{mra\ \left(-\frac{1}{2}make^2-\frac{ark^2e^2}{2m}\right)}{mr-ark\quad -mke^2},$$ when the last terms of the numerator and denominator are very small in comparison with the first, and may be considered as the $\dot{x}$ and $\dot{y}$ while mra is the x, and $mr-ark$ is the y. Treating it in this way, it may be stated thus:

$$x=\frac{mra}{mr-ark}+\frac{(mra)\,\frac{1}{2}mke^2-(mr-ark)\,\left(\frac{1}{2}mkae^2+\frac{ark^2e^2}{2m}\right)}{r^2(m-ak)^2}$$

$$\text{or } x=\frac{mra}{r(m-ak)}+\frac{(mra)\,mk-(mr-ark)\,\left(mka+\frac{ark^2}{m}\right)}{r^2(m-ak)^2}\times\tfrac{1}{2}e^2$$

The first term $\frac{mra}{r(m-ak)}$, or $\frac{ma}{m-ak}$, is evidently $=\varphi$, the focal distance of an infinitely slender pencil.

Therefore the aberration is expressed by the second term, which we must endeavour to simplify.

If we now perform the multiplication indicated by $-(mr-ark)\times\left(mka-\frac{ark^2}{m}\right)$, it is plain that $-mr\times mka$ destroys the first term $mra\times mk$ of the numerator of our small fraction, and there remains of this numerator $\left(ma^2rk^2-ar^2k^2+\frac{a^2r^2k}{m}\right)\frac{1}{2}e^2$, which is equal to $m^2a^2\left(\frac{rk^2}{m}-\frac{r^2k^2}{m^2a}+\frac{r^3k^3}{m^3}\right)\frac{1}{2}e^2$.

The denominator was $r^2(m-ak)^2$, and the fraction now becomes $\frac{m^2a^2}{(m-ak)^2}\left(\frac{k^2}{mr}-\frac{k^2}{m^2a}+\frac{k^3}{m^3}\right)\frac{1}{2}e^2$, which is evidently $=\varphi^2\left(\frac{k^2}{mr}-\frac{k^2}{m^2a}+\frac{k^3}{m^3}\right)\frac{e^2}{2}$. Now recollect that $k=\frac{1}{a}-\frac{1}{r}$. Therefore $\frac{k^3}{m^2}=\frac{k^2}{m^2}\left(\frac{1}{a}-\frac{1}{r}\right)=\frac{k^2}{m^2a}-\frac{k^2}{m^2r}$. Therefore, instead of $-\frac{k^2}{m^2a}$, write $\frac{-k^3}{m^2}-\frac{k^2}{mr}$, and we get the fraction $\varphi^2\left(\frac{k^3}{m^3}-\frac{k^3}{m^2}-\frac{k^2}{m^2r}+\frac{k^2}{mr}\right)\frac{e^2}{2}=\varphi^2\left(\frac{k^3}{m}-\frac{mk^3}{m^3}-\frac{mk^2}{m^3r}+\frac{m^2k^2}{m^3r}\right)\frac{e^2}{2}$, which is equal to $\varphi^2\frac{1-m}{m^3}\left(k^3-\frac{mk^2}{r}\right)\frac{e^2}{2}$, and finally to $-\varphi^2\frac{m-1}{m^3}\left(k^3-\frac{mk^2}{r}\right)\frac{e^2}{2}$.

Therefore the focal distance of refracted rays is $x=\varphi-\varphi^2\frac{m-1}{m^3}\left(k^3-\frac{mk^2}{r}\right)\frac{e^2}{2}$.

This consists of two parts. The first φ is the focal distance of an infinitely slender pencil of central rays, and the other $-\varphi^2\frac{m-1}{m^3}\left(k^3-\frac{mk^2}{r}\right)\frac{e^2}{2}$ is the aberration arising from the spherical figure of the refracting surface.

Our formula has thus at last put on a very simple form, and is vastly preferable to Dr Smith's for practice.

This aberration is evidently proportional to the square of the semi-aperture, and to the square of the distance φ: but in order to obtain this simplicity, several quantities were neglected. The assumption of the equality of AX to $\frac{e^2}{2a}$ is the first source of error. A much more accurate value of it would have been $\frac{2ae^2}{4a^2+e^2}$, for it is really $=\frac{e^2}{2a-AX}$. If for AX we substitute its approximated value $\frac{e^2}{2a}$, we should have $AX=\frac{e^2}{2a-\frac{e^2}{2a}}=\frac{2ae^2}{4a^2-e^2}$. To have used this value would not have much complicated the calculus; but it did not occur to us till we had finished the investigation, and it would have required the whole to be changed. The operation in page 246. col. 1. par. 3. is another source of error. But these errors are very inconsiderable when the aperture

ture is moderate. They increase for the most part with an increase of aperture, but not in the proportion of any regular function of it; so that we cannot improve the formula by any manageable process, and must be contented with it. The errors are precisely the same with those of Dr Smith's theorem, and indeed with those of any that we have seen, which are not vastly more complicated.

As this is to be frequently combined with subsequent operations, we shorten the expression by putting θ for $\frac{m-1}{m^3}\left(k^3-\frac{m\,k^2}{r}\right)\frac{e^2}{2}$. Then $\varphi^2\theta$ will express the aberration of the first refraction from the focal distance of an infinitely slender pencil; and now the focal distance of refracted rays is $f=\varphi-\varphi^2\theta$.

If the incident rays are parallel, r becomes infinite, and $\theta=\frac{m-1}{m^3}k^3\frac{e^2}{2}$. But in this case k becomes $=\frac{1}{a}$, and $\frac{1}{\varphi}=\frac{m-1}{ma}$, and $\varphi=\frac{ma}{m-1}$, and $\varphi^2\theta$ becomes $\frac{m^2a^2}{(m-1)^2}\times\frac{m-1}{m^3}\times\frac{1}{a^3}\times\frac{e^2}{2},=\frac{e^2}{(2m-1)ma}$. This is the aberration of extreme parallel rays.

We must now add the refraction of another surface.

Lemma 2. If the focal distance AG be changed by a small quantity G'g, the focal distance AH will also be changed by a small quantity Hh, and we shall have

$$m\cdot AG^2 : AH^2 = Gg : Hh.$$

Draw Mg, Mh, and the perpendiculars Gi, Hk. Then, because the sines of the angles of incidence are in a constant ratio to the sines of the angles of refraction, and the increments of these small angles are proportional to the increments of the sines, these increments of the angles are in the same constant ratio. Therefore,

We have the angle CMg to HMh as m to 1.

Now $Gg : Gi = AG : AM$,
and $Gi : hk = m\cdot AG : HA$,
and $hk : Hh = MA : AH$:
therefore $Gg : Hh = m\cdot AG^2 : AH^2$

The easiest and most perspicuous method for obtaining the aberration of rays twice refracted, will be to consider the first refraction as not having any aberration, and determine the aberration of the second refraction. Then conceive the focus of the first refraction as shifted by the aberration. This will produce a change in the focal distance of the second refraction, which may be determined by this Lemma.

Fig. 10. PROP. II. Let AM, BN (fig. 10.) be two spherical surfaces, including a refracting substance, and having their centres C and c in the line AG. Let the ray a A pass through the centres, which it will do without refraction. Let another ray m M, tending to G, be refracted by the first surface into MH, cutting the second surface in N, where it is farther refracted into NI. It is required to determine the focal distance BI?

It is plain that the sine of incidence on the second surface is to the sine of refraction into the surrounding air as 1 to m. Also BI may be determined in relation to BH, by means of BH, Nx, Be, and $\frac{1}{m}$, in the same way that AH was determined in relation to AG, by means of AG, MX, AC, and m.

Let the radius of the second surface be b, and let e still express the semi-aperture, (because it hardly differs from Nx). Also let α be the thickness of the lens. Then observe, that the focal distance of the rays refracted by the first surface, (neglecting the thickness of the lens and the aberration of the first surface), is the distance of the radiant point for the second refraction, or is the focal distance of rays incident on the second surface. In place of r therefore we must take φ; and as we made $k=\frac{1}{a}-\frac{1}{r}$, in order to abbreviate the calculus, let us now make $l=\frac{1}{b}-\frac{1}{\varphi}$; and make $\frac{1}{f}=\frac{1}{b}-m\,l$, as we made $\frac{1}{\varphi}=\frac{1}{a}-\frac{k}{m}$. Lastly, in place of $\theta=\frac{m-1}{m^3}\left(k^3-\frac{m\,k^2}{r}\right)\frac{e^2}{2}$, make $\theta'=\left(\frac{1}{m}-1\right)m^3\left(l^3-\frac{l^2}{m\,\varphi}\right)\frac{e^2}{2},=-\frac{m-1}{m}\left(m^2\,l^3-\frac{m^2\,l^2}{\varphi}\right)\frac{e^2}{2}$.

Thus we have got an expression similar to the other; and the focal distance BI, after two refractions, becomes $BI=f-f^2\theta'$.

But this is on the supposition that BH is equal to φ, whereas it is really $\varphi-\varphi^2\theta-\alpha$. This must occasion a change in the value just now obtained of BI. The source of the change is twofold. 1st, Because in the value $\frac{1}{b}-\frac{1}{\varphi}$, we must put $\frac{1}{b}-\frac{1}{\varphi-\varphi^2\theta-\alpha}$, and because we must do the same in the fraction $\frac{m^2\,l^2}{\varphi}$. In the second place, when the value of BH is diminished by the quantity $\varphi^2\theta+\alpha$, BI will suffer a change in the proportion determined by the 2d Lemma. The first difference may safely be neglected, because the value of θ is very small by reason of the coefficient $\frac{e^2}{2}$ being very small, and also because the variation bears a very small ratio to the quantity itself, when the true value of φ differs but little from that of the quantity for which it is employed. The chief change in BI is that which is determined by the Lemma. Therefore take from BI the variation of BH, multiplied by $\frac{m\,BI^2}{BH^2}$, which is very nearly $=\frac{mf^2}{\varphi^2}$. The product of this multiplication is $mf^2\theta+\frac{mf^2\alpha}{\varphi^2}$. This being taken from f, leaves us for the value of BI $f-\frac{f^2m\alpha}{\varphi^2}-f^2(m\theta+\theta')$.

In this value f is the focal distance of an infinitely slender pencil of rays twice refracted by a lens having no thickness; $\alpha\frac{mf^2}{\varphi}$ is the shortening occasioned by the thickness, and $f^2\,(m\theta+\theta')$ is the effect of the two aberrations arising from the aperture.

It will be convenient, for several collateral purposes, to exterminate from these formulæ the quantities k, l and φ. For this purpose make $\frac{1}{n}=\frac{1}{a}-\frac{1}{b}$. We have already $k=\frac{1}{a}-\frac{1}{r}$; and $\frac{1}{\varphi}=\frac{1}{a}-\frac{1}{ma}+\frac{1}{mr}$; and $l=\frac{1}{b}-\frac{2}{\varphi},=\frac{1}{-}-\frac{1}{a}+\frac{1}{ma}-\frac{1}{mr}$. Now for $\frac{1}{b}-\frac{1}{a}$ write $-\frac{1}{n}$, and

and we get $l=\frac{1}{ma}-\frac{1}{mr}-\frac{1}{n}$. Therefore $\frac{1}{f}=\frac{1}{b}-ml$ (by construction, page 347. Prop. II.) becomes $=\frac{1}{b}-\frac{1}{a}+\frac{1}{r}+\frac{m}{n},=\frac{m}{n}+\frac{1}{r}-\frac{1}{n},-\frac{m-1}{n}+\frac{1}{r}$.

This last value of $\frac{1}{f}$ (the reciprocal of the focus of a slender pencil twice refracted), viz. $\frac{m-1}{n}+\frac{1}{r}$, is the simplest that can be imagined, and makes n as a substitute for $\frac{1}{a}-\frac{1}{b}$; a most useful symbol, as we shall frequently find in the sequel. It also gives a very simple expression of the focal distance of parallel rays, which we may call the principal focal distance of the lens, and distinguish it in future by the symbol p; for the expression $\frac{1}{f}=\frac{m-1}{n}+\frac{1}{r}$ becomes $\frac{1}{p}=\frac{m-1}{n}$ when the incident light is parallel. And this gives us another very simple and useful measure of f; for $\frac{1}{f}$ becomes $=\frac{1}{p}+\frac{1}{r}$. These equations $\frac{1}{f}=\frac{m-1}{n}+\frac{1}{r}$, $\frac{1}{p}=\frac{m-1}{n}$, and $\frac{1}{f}=\frac{1}{p}+\frac{1}{r}$, deserve therefore to be made very familiar to the mind.

We may also take notice of another property of n. It is half the radius of an isosceles lens, which is equivalent to the lens whose radii are a and b: for suppose the lens to be isosceles, that is $a=b$; then $n=\frac{1}{a}-\frac{1}{a}$. Now the second a is negative if the first be positive, or positive if the first be negative. Therefore $\frac{1}{a}-\frac{1}{b}=\frac{1+b}{a^2}=\frac{a+a}{a^2}=\frac{2}{a}$, and $\frac{1}{n}=\frac{2}{a}$, and $n=\frac{a}{2}$. Now the focal distance of this lens is $\frac{m-1}{n}$, and so is that of the other, and they are equivalent.

But, to proceed with our investigation, recollect that we had $\theta=\frac{m-1}{m^3}\left(k^3-\frac{m\,k^2}{r}\right)\frac{e^2}{2}$. Therefore $m\,\theta=\frac{m-1}{m}\left(\frac{k^3}{m}-\frac{k^2}{r}\right)\frac{e^2}{2}$. And θ' was $=\frac{m-1}{m}\left(-m^2\,l^3+\frac{m\,l^2}{\varphi}\right)\frac{e^2}{2}$. Therefore $m\,\theta+\theta$, the aberration (neglecting the thickness of the lens) is $f^2\,\frac{m-1}{m}\left(\frac{k^3}{m}-\frac{k^2}{r}-m^2\,l^3+\frac{m\,l^2}{\varphi}\right)\frac{e^2}{2}$.

If we now write for k, l, and φ, their values as determined above, performing all the necessary multiplications, and arrange the terms in such a manner as to collect in one sum the coefficients of a, n, and r, we shall find 4 terms for the value of $m\,\theta$, and 10 for the value of θ'. The 4 are destroyed by as many with contrary signs in the value of θ', and there remain 6 terms to express the value of $m\theta+\theta'$, which we shall express by one symbol q; and the equation stands thus;

$$q=\frac{m-1}{m}\left(\frac{m^3}{n^3}-\frac{2m^2+m}{a\,n^2}+\frac{m+2}{a^2\,n}+\frac{3\,m^2+m}{r\,n^2}-\frac{4\,m+4}{a\,r\,n}+\frac{3m+2}{r^2\,n}\right)\frac{e^2}{2}.$$

The focal distance therefore of rays twice refracted, reckoned from the last surface, or BI, corrected for aberration, and for the thickness of the lens, is $f-f\,\frac{m\,\alpha}{\varphi^2}-f^2\,q$, consisting of three parts, viz. f, the focal distance of central rays; $f^2\frac{m\,\alpha}{\varphi^2}$, the correction for the thickness of the lens; and $f^2\,q$, the aberration.

The formula at the top of this column appears very complex, but is of very easy management, requiring only the preparation of the simple numbers which form the numerators of the fractions included in the parenthesis. When the incident rays are parallel, the terms vanish which have r in the denominator, so that only the three first terms are used.

We might here point out the cases which reduce the aberration expressed in the formula last referred to, to nothing; but as they can scarcely occur in the object-glass of a telescope, we omit it for the present, and proceed to the combination of two or more lenses.

Lemma 3. If AG be changed by a small quantity Gg, BI suffers a change I i, and Gg : I i=AG^2 : BI^2. For it is well known that the small angles GMg and INi are equal; and therefore their subtenses Gk, In are proportional to MG, NI, or to AG, AI nearly, when the aperture is moderate. Therefore we have (nearly)

Gk : In : AG : BI
In : Ii=AM : BI
Gg : Gk=AG : AM
Therefore Gg : Ii=AG^2 : BI^2

PROP. III. To determine the focal distance of rays refracted by two lenses placed near to each other on a common axis.

Let AM, BN (fig. 11.) be the surfaces of the first lens, and CO, DP be the surfaces of the second, and let β be the thickness of the second lens, and δ the interval between them. Let the radius of the anterior surface of the second lens be a', and the radius of its posterior surface be b'. Let m' be to 1 as the sine of incidence to the sine of refraction in the substance of the second lens. Lastly, let p' be the principal focal distance of the second lens. Let the extreme or marginal ray meet the axis in L after passing through both lenses, so that DL is the ultimate focal distance, reckoned from the last surface. Fig. 11.

It is plain that DL may be determined by means of a', b', m', p', and CI, in the same manner that BI was determined by means of a, b, m, p, and AG.

The value of BI is $f-m\,\alpha\,\frac{f^2}{\varphi^2}-f^2\,q$. Take from this the interval δ, and we have CI$=f-m\,\alpha\,\frac{f^2}{\varphi^2}-\delta-f^2\,q$. Let the small part $-m\,\alpha\,\frac{f^2}{\varphi^2}-\delta-f^2\,q$ be neglected for the present, and let CI be supposed $=f$. As we formed φ, f, and q, by means of a, b, m, n, and r,

r, let us now form φ', f', and q', for the second lens, by means of a', b', m', n', $\left(=\frac{1}{a'}-\frac{1}{b'}\right)$, and r'. φ' will be the focal distance of a slender pencil refracted by the first surface, f will be the focal distance of this pencil after two refractions, and q' will be the coefficient of the aberration, neglecting the thickness and interval of the lenses.

Proceeding in this way, DL will be $=f'-m\beta\frac{f^2}{\varphi}-f'^2 q$. But because CI is really less than f, by the quantity $m\alpha\frac{f^2}{\varphi'^2}+\partial+f^2 q'$, we must (by Lemma 3.) subtract the product of this quantity, multiplied by $\frac{\mathrm{DL}}{\mathrm{BI}^2}$, (which is nearly $\frac{f'^2}{f^2}$), from $f'-m\beta\frac{f'^2}{\varphi'^2}f'^2 q'$.

By this process we shall have

$$\mathrm{DL}=f'-f'^2\left(\frac{m\alpha}{\varphi^2}+\frac{\partial}{f^2}+\frac{m'\beta}{\varphi'^2}\right)-f'^2(q+q').$$

The first term f' of this value of DI is the focal distance of a slender pencil of central rays refracted by both lenses, neglecting their thickness and distance; the second term, $-f'^2\left(\frac{m\alpha}{\varphi^2}+\frac{\partial}{f^2}+\frac{m'\beta}{\varphi'^2}\right)$ is the correction necessary for these circumstances; and the third term, $-f'^2(q+q')$, is the correction for the aperture $2e$. And it is evident that q' is a formula precisely similar to q, containing the same number of terms, and differing only by the m', a', n', and r', employed in place of m, a, n, and r.

It is also evident, that if there be a third lens, we shall obtain its focal distance by a process precisely similar to that by which we obtained DL; and so on for any number of lenses.

Thus have we obtained formulæ by which the foci of rays are determined in the most general terms, and in such a manner as shall point out the connection of the curvatures, thicknesses, and distances of the lenses, with their spherical aberrations, and with the final aberration of the compound lens, and give the aberrations in separate symbols, so that we can treat them by themselves, and subject them to any conditions which may enable us to correct one of them by another.

We also see in general, that the corrections for the thickness and distance of the lenses are exhibited in terms which involve only the focal distances of central rays, and have very little influence on the aberrations, and still less on the ratio of the aberrations of the different lenses. This is a most convenient circumstance; for we may neglect them while we are determining q and q', and in determining the ratio of the focal distances of the several lenses, on which the correction of the chromatic abberration chiefly depends. Therefore, in the construction of a compound lens for uniting the different colours, we may neglect this correction for the thickness and distance till the end of the process. When we apply it, we shall find that it chiefly affects the final focal distance, making it somewhat longer, but has hardly any influence either on the chromatic or spherical aberration. We do not hesitate to say, that the final formulæ here given are abundantly accurate, while they are vastly more manageable than those employed by Euler or D'Alembert. We have calculated trigonometrically the progress of the rays through one of the glasses, which will be given as an example, giving it a very extravagant aperture, that the errors of the formulæ might be very remarkable. We found the real aberration exceed the aberration assigned by the formula by no more than $\frac{1}{35}$th part, a difference which is quite insignificant. The process here given derives its simplicity from the frequent occurrence of harmonic proportions in all optical theorems. This enabled Mr Clairaut to employ the reciprocals of the radii and distances with so much simplicity and generality.

We consider it as another advantage of Mr Clairaut's method, that it gives, by the way, formulæ for the more ordinary questions in optics, which are of wonderful simplicity, and most easily remembered. The chief problems in the elementary construction of optical instruments relate to the focal distances of central rays. This determines the focal distances and arrangement of the glasses. All the rest may be called the refinement of optics; teaching us how to avoid or correct the indistinctness, the colours and the distortions, which are produced in the images formed by these simple constructions. We shall mention a few of these formulæ which occur in our process, and tend greatly to abbreviate it when managed by an experienced analyst.

Let m be to 1 as the sine of incidence to the sine of refraction; let a and b be the radii of the anterior and posterior surfaces of a lens; let r be the distance of the radiant point, or the focus of incident central rays, and f the distance of the conjugate focus; and let p be the principal focal distance of the lens, or the focal distance of parallel rays. Make $\frac{1}{n}$ equal to all $\frac{1}{a}-\frac{1}{b}$; let the same letters a', b', r', &c. express the same things for a second lens; and a'', b'', r'', &c. express them for a third; and so on. Then we have $\frac{1}{f}=\frac{m-1}{n}+\frac{1}{r}$; $\frac{1}{f'}=\frac{m'-1}{n'}+\frac{1}{r'}$; $\frac{1}{f''}=\frac{m''-1}{n''}+\frac{1}{r''}$, &c.

Therefore when the incident light is parallel, and r infinite, we have $\frac{1}{p}=\frac{m-1}{n}$; $\frac{1}{p'}=\frac{m'-1}{n'}$; $\frac{1}{p''}=\frac{m''-1}{n''}$, &c.

And when several lenses are contiguous, so that their intervals may be neglected, and therefore $\frac{1}{f}$, belonging to the first lens, becomes $\frac{1}{r}$, belonging to the second, we have

$$1.\ \frac{1}{r'}=\frac{1}{f}=\frac{m-1}{n}+\frac{1}{r},=\frac{1}{p}+\frac{1}{r}.$$

$$2.\ \frac{1}{r''}=\frac{1}{f'},=\frac{m'-1}{n'}+\frac{m-1}{n}+\frac{1}{r},=\frac{1}{p'}+\frac{1}{p}+\frac{1}{r}.$$

$$3.\ \frac{1}{f''}=\frac{m''-1}{n''}+\frac{m'-1}{n}+\frac{m-1}{n}+\frac{1}{r},=\frac{1}{p''}+\frac{1}{p'}+\frac{1}{p}+\frac{1}{r}.$$

Nothing can be more easily remembered than these formulæ, how numerous so ever the glasses may be.

Having thus obtained the necessary analysis and formula,

mula, it now remains to apply them to the construction of achromatic lenses; in which it fortunately happens, that the employment of several surfaces, in order to produce the union of the differently refrangible rays, enables us at the same time to employ them for correcting each other's spherical aberration.

In the article OPTICS we gave a general notion of the principle on which we may proceed in our endeavours to unite the differently refrangible rays. A white or compounded ray is separated by refraction into its component coloured rays, and they are diffused over a small angular space. Thus it appears, that the glass used by Sir Isaac Newton in his experiments diffused a white ray, which was incident on its posterior surface in an angle of 30°, in such a manner that the extreme red ray emerged into air, making an angle of 50° $21\frac{1}{3}'$ with the perpendicular; the extreme violet ray emerged in an angle of 51° $15\frac{1}{3}'$; and the ray which was in the confines of green and blue, emerged in an angle of 50° $48\frac{1}{7}'$. If the sine of the angle 30° of incidence be called 0.5, which it really is, the sine of the emergence of the red ray will be 0.77; that of the violet ray will be 0.78; and that of the intermediate ray will be $0.77\frac{1}{2}$, an exact mean between the two extremes. This ray may therefore be called the mean refrangible ray, and the ratio of $77\frac{1}{2}$ to 50, or of 1.55 to 1, will very properly express the mean refraction of this glass; and we have for this glass $m=1.55$. The sine of refraction, being measured on a scale, of which the sine of incidence occupies 100 parts, will be 154 for the red ray, 155 for the mean ray, and 156 for the violet ray. This number, or its ratio to unity, is commonly taken to represent the refractive power of the glass. There is some impropriety in this, unless we consider ratios as measured by their logarithms: for if m be 1, the substance does not refract at all. The refractive power can be properly measured only by the refraction which it produces; that is, by the change which it makes in the direction of the light, or the angle contained between the incident and refracted rays. If two substances produce such deviations always in one proportion, we should then say that their refractive powers are in that proportion. This is not true in any substances; but the sines of the angles, contained between the refracted ray and the perpendicular, are always in one proportion when the angle of incidence in both substances is the same. This being a cognisable function of the real refraction, has therefore been assumed as the only convenient measure of the refractive powers. Although it is not strictly just, it answers extremely well in the most usual cases in optical instruments: the refractions are moderate; and the sines are very nearly as the angles contained between the rays and the perpendicular; and the real angles of refraction, or deflections of the rays, are almost exactly proportional to $m-1$. The most natural and obvious measure of the refractive powers would therefore be $m-1$. But this would embarrass some very frequent calculations; and we therefore find it best, on the whole, to take m itself for the measure of the refractive power.

The separation of the red, violet, and intervening rays, has been called *dispersion;* and although this arises merely from a difference of the refractive power in respect of the different rays, it is convenient to distinguish this particular modification of the refractive power by a name, and we call it the DISPERSIVE POWER of the refracting substance.

It is susceptible of degrees; for a piece of flint-glass will refract the light, so that when the sine of refraction of the red ray is 77, the sine of the refraction of the violet ray is nearly $78\frac{1}{2}$; or if the sine of refraction of the red ray, measured on a particular scale, is 1.54, the sine of refraction of the violet ray is 1.57. The dispersion of this substance, being measured by the difference of the extreme sines of refraction, is greater than the dispersion of the other glass, in the proportion of 3 to 2.

But this alone is not a sufficient measure of the absolute dispersive power of a substance. Although the ratio of 1.54 to 1.56 remains constant, whatever the real magnitude of the refractions of common glass may be, and though we therefore say that its dispersive power is constant, we know, that by increasing the incidence and the refraction, the absolute dispersion is also increased. Another substance shows the same properties, and in a particular case may produce the same dispersion; yet it has not for this sole reason the same dispersive power. If indeed the incidence and the refraction of the mean ray be also the same, the dispersive power cannot be said to differ; but if the incidence and the refraction of the mean ray be less, the dispersive power must be considered as greater, though the actual dispersion be the same; because if we increase the incidence till it becomes equal to that in the common glass, the dispersion will now be increased. The proper way of conceiving the dispersion therefore is, to consider it as a portion of the whole refraction; and if we find a substance making the same dispersion with half the general refraction, we must say that the dispersive quality is double; because by making the refraction equal, the dispersion will really be double.

If therefore we take $\dot{m}$ as a symbol of the separation of the extreme rays from the middle ray, $\frac{\dot{m}}{m-1}$ is the natural measure of the dispersive power. We shall express this in the Leibnitzian notation, thus $\frac{dm}{m-1}$, that we may avoid the indistinctness which the Newtonian notation would occasion when m is changed for m' or m''.

It is not unusual for optical writers to take the whole separation of the red and violet rays for the measure of the dispersive power, and to compare this with the refracting power with respect to one of the extreme rays. But it is surely better to consider the mean refraction as the measure of the refracting power: and the deviation of either of the extremes from this mean is a proper enough measure of the dispersion, being always half of it. It is attended with this convenience, that being introduced into our computations as a quantity infinitely small, and treated as such for the ease of computation; while it is really a quantity of sensible magnitude; the errors arising from this supposition are diminished greatly, by taking one half of the deviation, and comparing it with the mean refraction. This method has, however, this inconvenience, that it does not exhibit at once the refractive power in all substances respecting any particular colour of light; for it is not the ray of any particular colour that suffers the mean refraction. In common glass it is the ray which is in the confines of the yellow and blue; in flint-glass it is nearly the middle

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dle blue ray; and in other substances it is a different ray. These circumstances appear plainly in the different proportions of the colours of the prismatic spectrum exhibited by different substances. This will be considered afterwards, being a great bar to the perfection of achromatic instruments.

The way in which an achromatic lens is constructed is, to make use of a contrary refraction of a second lens to destroy the dispersion or spherical aberration of the first.

The first purpose will be answered if $\frac{dm}{n}$ be equal to $-\frac{dm'}{n'}$. For, in order that the different coloured rays may be collected into one point by two lenses, it is only necessary that $\frac{1}{f'}$, the reciprocal of the focal distance of rays refracted by both, may be the same for the extreme and mean rays, that is, that $\frac{m+dm-1}{n}+\frac{m'+dm'-1}{n'}+\frac{1}{r}$ be of the same value with $\frac{m-1}{n}+\frac{m'-1}{n'}+\frac{1}{r}$, which must happen if $\frac{dm}{n}+\frac{dm'}{n'}$ be $=0$, or $\frac{dm}{n}=-\frac{dm'}{n}$. This may be seen in another way, more comprehensible by such as are not versant in these discussions. In order that the extreme colours which are separated by the first lens may be rendered parallel by the second; we have shown already that n and n' are proportional to the radii of the equivalent isosceles lenses, being the halves of these radii. They are therefore (in these small refractions) inversely proportional to the angles formed by the surfaces at the edges of the lenses. n' may therefore be taken for the angle of the first lens, and n for that of the second. Now the small refraction by a prism, whose angle (also small) is n', is $\overline{m-1}\times n$. The dispersive power being now substituted for the refractive power, we have for this refraction of the prism $dm\times n'$. This must be destroyed by the opposite refraction of the other prism $dm'\times n$. Therefore $dm\times n'=dm'\times n$, or $\frac{dm}{n}=-\frac{dm'}{n'}$. In like manner, this effect will be produced by three lenses if $\frac{dm}{n}+\frac{dm'}{n'}+\frac{dm''}{n''}$ be $=0$, &c.

Lastly, the errors arising from the spherical figure, which we expressed by $-R^2\ (q+q')$ will be corrected if $q+q'$ be $=0$. We are therefore to discover the adjustments of the quantities employed in the preceding formulæ, which will insure these conditions. It will render the process more perspicuous if we collect into one view the significations of our various symbols, and the principal equations which we are to employ.

1. The ratios to unity of the sines of mean incidence in the different media are - m, m' m''.
2. The ratio of the differences of the sines of the extremes - - - - $\frac{dm}{dm'}$, $=u$.
3. The ratio $\frac{m-1}{m'-1}$ - - - - - $=c$.
4. The radii of the surfaces $a, b;\ a', b';\ a'', b''$.
5. The principal focal distances, or the focal distances of parallel central rays, - p, p', p''.
6. The focal distance of the compound lens P.
7. The distance of the radiant point, or of the focus of incident rays on each lens r, r', r''.
8. The focal distance of the rays refracted by each lens - - - - f, f', f''.
9. The focal distance of rays refracted by the compound lens - - - - F.
10. The half breadth of the lens - - - e.

Also the following subsidiary values:

1. $\frac{1}{n}=\frac{1}{a}-\frac{1}{b};\ \frac{1}{n'}=\frac{1}{a'}-\frac{1}{b'};\ \frac{1}{n''}=\frac{1}{a''}-\frac{1}{b''}.$

2. $q=\frac{m-1}{m}\left(\frac{m'^3}{n^3}-\frac{2m^2+m}{an^2}+\frac{m+2}{a^2n}+\frac{3m^2+m}{rn^2}-\frac{4(m+1)}{arn}+\frac{3m+2}{r^2n}\right)\frac{e^2}{2}$. And q' and q'' must be formed in the same manner from m', a', n', r'; and from m'', a'', n'', r'', as q is formed from m, a, n, r.

3. Also because in the case of an object-glass, r is infinitely great, the last term $\frac{1}{r}$ in all the values of $\frac{1}{f}$, $\frac{1}{f'}$, $\frac{1}{f''}$, $\frac{1}{r'}$, $\frac{1}{r''}$, will vanish, and we shall also have F=P.

Therefore in a double object-glass $\frac{1}{P}=\frac{m'-1}{n'}+\frac{m-1}{n}=\frac{1}{p}+\frac{1}{p'}$.

And in a triple object-glass $\frac{1}{P}=\frac{m''-1}{n''}+\frac{m'-1}{n'}+\frac{m-1}{n},=\frac{1}{p''}+\frac{1}{p'}+\frac{1}{p}$.

Also, in a double object-glass, the correction of spherical aberration requires $q+q'=v$.

And a triple object-glass requires $q+q'+q''=v$. For the whole error is multiplied by F^2, and by $\frac{1}{2}e^2$; and therefore the equation which corrects this error may be divided by $F^2\ \frac{1}{2}\ e^2$.

This equation in the fourteenth line from the top of the column, giving the value of q, q', q'', may be much simplified as follows: In the first place, they may be divided by m, m', or m'', by applying them properly to the terms within the parenthesis, and expunging them from the denominator of the general factors $\frac{m-1}{m}$, $\frac{m'-1}{m'}$, $\frac{m''-1}{m''}$. This does not alter the values of q, q', and q''. In the second place the whole equations may be afterwards divided by $m'-1$. This will give the values of $\frac{q}{m'-1}$, $\frac{q'}{m'-1}$, and $\frac{q''}{m'-1}$, which will still be equal to nothing if $q+q'+q''$ be equal to nothing.

This division reduces the general factor $\frac{m'-1}{m'}$ of q' to $\frac{1}{m'}$. And in the equation for q we obtain, in place of the general factor $\frac{m-1}{m}$, the factor $\frac{m-1}{m'-1}$, or c. This will also be the factor of the value of q'' when the third lens is of the same substance with the first, as is general-

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ly the case. And, in the third place, since the rays incident on the first lens are parallel, all the terms vanish from the value of q in which $\frac{1}{r}$ is found, and there remain only the three first, viz. $\frac{m^3}{n^3}-\frac{2m^2+m}{an^2}+\frac{m+2}{a^2n}$.

Performing these operations, we have

$$\frac{q}{m'-1}=c\left(\frac{m^2}{n^3}-\frac{2m+1}{an^2}+\frac{m+2}{ma^2n}\right)\frac{e^2}{2}$$

$$\frac{q'}{m'-1}=\left(\frac{m'^2}{n'^3}-\frac{2'm+1}{a'n'2}+\frac{m'+2}{m'a'^2n'}+\frac{3m'+1}{r'n'^2}-\frac{(4m'+1)}{m'a'r'n'}+\frac{3'm+2}{m'r'^2n'}\right)\frac{e^2}{2}$$

$$\frac{q''}{m'-1}=c\left(\frac{m^2}{n''^3}-\frac{2m+1}{a''n''^2}+\frac{m+2}{m''a''^2n''}+\frac{3m+1}{r''n''^2}+\frac{(4m+1)}{m''a''r''n''}+\frac{3m+2}{m''r''^2n''}\right)\frac{e^2}{2}.$$

Let us now apply this investigation to the construction of an object-glass; and we shall begin with a double lens.

Construction of a Double Achromatic Object-glass.

Here we have to determine four radii a, b, a', and b'. Make $n=1$. This greatly simplifies the calculus, by exterminating it from all the denominators. This gives for the equation $\frac{dm}{n}+\frac{dm'}{n'}=0$, the equation $dm+\frac{dm'}{n'}=0$, or $dm=-\frac{dm'}{n'}$, and $\frac{1}{n'}=-\frac{dm}{dm'}, =-u$. Also we have r', the focal distance of the light incident on the second lens, the same with the principal focal distance p of the first lens, (neglecting the interval, if any). Now $\frac{1}{p}=\frac{m-1}{n}$, which in the present case is $=m-1$. Also $\frac{1}{p}$ is $=-u(m'-1)$, and $\frac{1}{P}=m-1-u(m'-1)=u'$.

Make these substitutions in the values of $\frac{q}{m-1}$ and $\frac{q'}{m'-1}$, and we obtain the following equation:

$$cm^2-\frac{c(2m+1)}{a}+\frac{c(m+2)}{ma^2}-u^3m'^2-\frac{u^2(2m'+1)}{a'}-\frac{u(m'+2)}{m'a'^2}+u^2(3m'+1)(m-1)+\frac{4u(m'+1)(m-1)}{m'a'}-\frac{u(3m'+2)(m-1)^2}{m'}=0.$$

Arrange these terms in order, according as they are factors of $\frac{1}{a^2}$, $\frac{1}{a}$, $\frac{1}{a'^2}$, $\frac{1}{a'}$, or independent quantities. It puts on this form:

$$\frac{c(m+2)}{m}\times\frac{1}{a^2}-c'(2m+1)\times\frac{1}{a}-\frac{u(m'+2)}{m'}\times\frac{1}{a'^2}-\left(u^2(2m'+1)-\frac{4u(m'+1)(m-1)}{m'}\right)\times\frac{1}{a'}+cm^2+u^2(3m'+1)(m-1)-u^3m'^2-\frac{u(3m'+2)(m-1)^2}{m'}=0.$$

Let A be the coefficient of $\frac{1}{a^2}$, B that of $\frac{1}{a}$, C that of $\frac{1}{a'^2}$, D that of $\frac{1}{a'}$, and E the sum of the independent quantity; that is, let A be $=\frac{c(m+2)}{m}$, $B=c(2m+1)$, $C=\frac{u(m'+2)}{m'}$, $D=u^2(2m'+2)-\frac{4u(m'+1)(m-1)}{m'}$ and $E=cm^2+u^2(3m'+1)(m-1)-u^3m^2-\frac{u(3m'+2)(m-1)^2}{m'}$.

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Our final equation becomes

$$\frac{A}{a^2}-\frac{B}{a}-\frac{C}{a'^2}-\frac{D}{a'}+E=0.$$

The coefficients of this equation and the independent quantity are all known, from our knowledge of m, m' dm, dm'; and we are to find the value of a and a', and from them and $n=1$ to find the values of b and b'.

But it is evidently an indeterminate equation, because there are two unknown quantities; so that there may be an infinity of solutions. It must be rendered determinate by means of some other conditions to which it may be subjected. These conditions must depend on some other circumstances which may direct our choice.

One circumstance occurs to us which we think of very great consequence. In the passage of light from one substance to another, there is always a considerable portion reflected from the posterior surface of the first and from the anterior surface of the last; and this reflection is more copious in proportion to the refraction. This loss of light will therefore be diminished by making the internal surfaces of the lenses to coincide; that is, by making $b=a'$. This will be attended with another advantage. If we put between the glasses a substance of nearly the same refracting power, we shall not only completely prevent this loss of light, but we shall greatly diminish the errors which arise from an imperfect polish of the surfaces. We have tried this, and find the effect very surprising. The lens being polished immediately after the figure has been given it, and while it was almost impervious to light by reason of its roughness, which was still sensible to the naked eye, performed as well as when finished in the finest manner.

N. B. This condition, by taking away one refraction, obliges us to increase those which remain, and therefore increases the spherical aberrations. And since our formulæ do not fully remove those (by reason of the small quantities neglected in the process), it is uncertain whether this condition be the most eligible. We have, however, no direct argument to the contrary.

Let us see what determination this gives us.

In this case $\frac{1}{a'}=\frac{1}{b}, =\frac{1}{a}-1$. For because $\frac{1}{n}=\frac{1}{a}-\frac{1}{b}$ and $n=1$, we have $1+\frac{1}{b}=\frac{1}{a}$, and $\frac{1}{b}=\frac{1}{a}-1$. Therefore $\frac{1}{a'^2}=\frac{1}{a^2}-\frac{2}{a}+1$. Therefore, in our final equation, put $\frac{1}{a^2}-\frac{2}{a}+1$ in place of $\frac{1}{a'^2}$, and $\frac{1}{a}-1$ in place

place

place of $\frac{1}{a'}$, and it becomes $\frac{A-C}{a^2}-\frac{B+D-2C}{a}+E+D-C=0$.

Thus have we arrived at a common affected quadratic equation, where $\frac{1}{a}$ is the unknown quantity. It has the common form $px^2+qx+r=0$, where p is $=A-C$, q is equal to $2C-B-D$, r is equal to $E+D-C$, and x is equal to $\frac{1}{a}$.

Divide the equation by p, and we have $x^2+\frac{q}{p}x+\frac{r}{p}=0$. Make $s=\frac{q}{p}$ and $t=\frac{r}{p}$, and we have $x^2+sx+t=0$. This gives us finally $\frac{1}{a}$, or $x=-\frac{1}{2}s\pm\sqrt{\frac{1}{4}s^2-t}$.

This value of $\frac{1}{a}$ is taken from a scale of which the unit is half the radius of the isosceles lens which is equivalent to the first lens, or has the same focal distance with it. We must then find (on the same scale) the value of b, viz. $\frac{1}{a}-1$, which is also the value of a', Having obtained a', we must find b' by means of the equation $\frac{1}{n'}=\frac{1}{a'}-\frac{1}{b'}$, and therefore $\frac{1}{b}=\frac{1}{a'}-\frac{1}{n'}$. But $\frac{1}{n'}=u$. Therefore $\frac{1}{b'}=\frac{1}{a'}+u, =\frac{1}{a}+u-1$.

Thus is our object-glass constructed; and we must determine its focal distance, or its reciprocal $\frac{1}{P}$. This is $=m-1-u\,(m'-1)$.

All these radii and distances are measured on a scale of which n is the unit. But it is more convenient to measure every thing by the focal distance of the compound object-glass. This gives us the proportion which all the distances bear to it. Therefore, calling P unity, in order to obtain $\frac{1}{a}$ on this scale, we have only to state the analogy $m-1-u\,(m'-1):1=\frac{1}{a}:\frac{1}{A}$, and A is the radius of our first surface measured on a scale of which P is the unit.

If, in the formula which expresses the final equation for $\frac{1}{a}$, the value of t should be positive, and greater than $\frac{1}{4}s^2$, the equation has imaginary roots; and it is not possible with the glasses employed, and the conditions assumed, to correct both the chromatic and spherical aberrations.

If t is negative and equal to $\frac{1}{4}s^2$, the radical part of the value is $=0$, and $\frac{1}{a}=-\frac{1}{2}s$. But if it be negative or positive, but less than $\frac{1}{4}s^2$, the equation has two real roots, which will give two constructions. That is to be preferred which gives the smallest curvature of the surfaces; because, since in our formulæ which determine the spherical aberration some quantities are neglected, these quantities are always greater when a large arch (that is, an arch of many degrees) is employed. No radius should be admitted which is much less than $\frac{1}{3}$ of the focal distance.

All this process will be made plain and easy by an example.

Very careful experiments have shown, that in common crown-glass the sine of incidence is to the sine of refraction as 1.526 is to 1, and that in the generality of flint-glass it is as 1.604 to 1. Also that $\frac{dm}{dm'}=0.6054=u$. Therefore $m-1=0.526$; $m'-1=0.604$; $c=\frac{m-1}{m'-1}, =0.87086$. By these numbers we can compute the coefficients of our final equation. We shall find them as follows:

$$\begin{aligned} A&=2.012\\ B&=3.529\\ C&=1.360\\ D&=-0.526\\ E&=1.8659\end{aligned}$$

The general equation (p. 252. col. 2. lin. 8.), when subjected to the assumed coincidence of the internal surfaces, is $\frac{A-C}{a^2}-\frac{B+D-2C}{a}+E+D-C=0$. $A-C$ is $=0.652$; $B+D-2C$ is $=0.283$; and $E+D-C$ is $=-0.020$; and the equation with numerical coefficients is $\frac{0.652}{a^2}-\frac{0.283}{a}-0.020=0$, which corresponds to the equation $px^2+qx+r=0$. We must now make $s=\frac{q}{p}, =\frac{0.283}{0.652}, =0.434$, and $t=\frac{r}{p}, =\frac{0.02}{0.652}, =0{,}0307$.

This gives us the final quadratic equation $\frac{1}{a^2}-\frac{0.434}{a}-0.0307=0$. To solve this, we have $-\frac{1}{2}s=0.217$, and $\frac{1}{4}s^2-0.0471$. From this take t, which is $=-0.0307$ (that is, to 0.0471 add 0.0307), and we obtain 0.0778, the square root of which is $=0.2789$. Therefore, finally, $\frac{1}{a}=0.2170\pm0.2789$, which is either 0.4959 or -0.0619. It is plain that the first must be preferred, because the second gives a negative radius, or makes the first surface of the crown-glass concave. Now as the convergence of the rays is to be produced by the crown-glass, the other surface must become very convex, and occasion great errors in the computed aberration. We therefore retain 0.4959 for the value of $\frac{1}{a}$, and a is $=\frac{1}{0.4959}, =2.0166$.

To obtain b, use the equation $\frac{1}{b}=\frac{1}{a}-1$, which gives $\frac{1}{b}=-0.5041$, and therefore a convex surface. b is therefore $=\frac{1}{0.5041}=1.9837$.

a' is the same with b, and $\frac{1}{a'}=-0.5041$.

To obtain b', use the equation $\frac{1}{b'}=\frac{1}{a'}+u$. Now $u=0.6054$, and $\frac{1}{a'}=-0.5041$. The sum of these is 0.1013;

0.1013; and since it is positive, the surface is concave.

$b' = \frac{1}{.1013} = 9.872.$

Lastly, $\frac{1}{P} = m - 1 - u\ (m' - 1) = 0.1603$, and $P = \frac{1}{0.1603}, = 0.2383.$

Now to obtain all the measures in terms of the focal distance P, we have only to divide the measures already found by 6.2383, and the quotients are the measures wanted.

$$\begin{aligned} \text{Therefore } a &= \frac{2.0166}{6.2383} = 0.32325 \\ b &= \frac{1.9837}{6.2383} = -0.31798 \\ a' &= \quad - \ - \quad = -0.31798 \\ b' &= \frac{9.872}{6.2383} = \ \ 1.5825 \\ P &= \quad - \quad \ \ 1. \end{aligned}$$

If it be intended that the focal distance of the object-glass shall be any number n of inches or feet, we have only to multiply each of the above radii by n, and we have their lengths in inches or feet.

Thus we have completed the investigation of the construction of a double object-glass. Although this was intricate, the final result is abundantly simple for practice, especially with the assistance of logarithms. The only troublesome thing is the preparation of the numerical coefficients A, B, C, D, E of the final equation. Strict attention must also be paid to the positive and negative signs of the quantities employed.

We might propose other conditions. Thus it is natural to prefer for the first or crown-glass lens such a form as shall give it the smallest possible aberration. This will require a small aberration of the flint-glass to correct it. But a little reflection will convince us that this form will not be good. The focal distance of the crown-glass must not exceed one-third of that of the compound glass; these two being nearly in the proportion of $dm' - dm$ to dm'. Therefore if this form be adopted, and a be made about $\frac{1}{6}$th of b, it will not exceed $\frac{1}{7}$th of P. Therefore, although we may produce a most accurate union of the central and marginal rays by opposite aberrations, there will be a considerable aberration of some rays which are between the centre and the margin.

It is absolutely impossible to collect into one point the whole rays (though the very remotest rays are united with the central rays), except in a very particular case, which cannot obtain in an object-glass; and the small quantities which are neglected in the formula which we have given for the spherical aberration, produce errors which do not follow any proportion of the aperture which can be expressed by an equation of a manageable form. When the aperture is very large, it is better not to correct the aberration for the whole aperture, but for about $\frac{5}{6}$ths of it. When the rays corresponding to this distance are made to coincide with the central rays by means of opposite aberrations, the rays which are beyond this distance will be united with some of those which are nearer to the centre, and the whole diffusion will be considerably diminished. Dr Smith has illustrated this in a very perspicuous manner in his theory of his Catoptric Microscope.

But although we cannot adopt this form of an object-glass, there may be other considerations which may lead us to prefer some particular form of the crown-glass, or of the flint-glass. We shall therefore adapt our general equation $\frac{A}{a^2} - \frac{B}{a} - \frac{C}{a'^2} - \frac{D}{a'} + E = 0$ to this condition.

Therefore let h express this selected ratio of the two radii of the crown-glass, making $\frac{a}{b} = h$ (remembering always that a is positive and b negative in the case of a double convex, and h is a negative number).

With this condition we have $\frac{1}{b} = \frac{h}{a}$. But when we make n the unit of our formula of aberration, $\frac{1}{b} = \frac{1}{a} - 1$. Therefore $1 = \frac{1}{a} - \frac{h}{a}$, and $\frac{1}{a} = \frac{1}{1-h}$. Now substitute this for $\frac{1}{a}$ in the general equation, and change all the signs (which still preserves it $=0$), and we obtain

$$\frac{C}{a'^2} + \frac{D}{a'} - E - \frac{A}{(1-h)^2} + \frac{B}{1-h} = 0.$$

By this equation we are to find $\frac{1}{a'}$, or the radius of the anterior surface of the flint-glass. The equation is of this form $px^2 + qx + r = 0$, and we must again make $s = \frac{q}{p}$ and $t = \frac{r}{p}$. Therefore $s = \frac{D}{C}$, and $t = \frac{1}{C} \times \left(\frac{B}{1-h} - \frac{A}{(1-h)^2} - E\right)$. Then, finally,

$$\frac{1}{a'} = -\tfrac{1}{2}s \pm \sqrt{\tfrac{1}{4}s^2 - t}.$$

It may be worth while to take a particular case of this condition. Suppose the crown-glass to be of equal convexities on both sides. This has some advantages: We can tell with precision whether the curvatures are precisely equal, by measuring the focal distance of rays reflected back from its posterior surface. These distances will be precisely equal. Now it is of the utmost importance in the construction of an object-glass which is to correct the spherical aberration, that the forms be precisely such as are required by our formulæ.

In this case of a lens equally convex on both sides $\frac{1}{a}$ is $= -\frac{1}{b}, = \frac{1}{2}$. Substitute this value for $\frac{1}{a}$ in the general equation $\frac{A}{a^2} - \frac{B}{a} - \frac{C}{a'^2} - \frac{D}{a'} + E = 0$, and then $\frac{A}{a^2} = \frac{A}{4}$; $\frac{B}{a}$ becomes $\frac{B}{2}$. Now change all the signs, and we have $\frac{C}{a'^2} + \frac{D}{a'} - E - \frac{A}{4} + \frac{B}{2} = 0$, by which we are to find a'. This in numbers is $\frac{1.360}{a'^2} - \frac{0.526}{a'}$

$\frac{0.526}{a'} - 0.6044 = 0$. Then $s = \frac{-0.526}{1.360}, = 0.3867$, and $t = \frac{-0.6044}{1.360}, = -0.4444$. Then $-\frac{1}{2}s = 0.1933$; $\frac{1}{4}s^2 = 0.0374$; and $\sqrt{\frac{1}{4}S^2 - t} = \pm 0.6941$; so that $\frac{1}{a'} = 0.1933 \pm 0.6941$. This gives two real roots, viz. 0.8874, and −0.5008. If we take the first, we shall have a convex anterior surface for the flint-glass, and consequently a very deep concave for the posterior surface. We therefore take the second or negative root −0.5008.

We find $\frac{1}{b'}$, as before, by the equation $\frac{1}{b'} = \frac{1}{a'} + u, = 0.1046$, which will give a large value of b'.

We had $\frac{1}{a} = \frac{1}{2}$

and $\frac{1}{b} = -\frac{1}{2}$

and $\frac{1}{P}$ is the same as in the former case, viz. 0.1603.

Having all these reciprocals, we may find a, b, a', b', and P; and then dividing them by P, we obtain finally

$$\begin{aligned} a &= 0.3206 \\ b &= -0.3206 \\ a' &= -0.3201 \\ b' &= 1.533 \\ P &= 1. \end{aligned}$$

By comparing this object-glass with the former, we may remark, that diminishing a a little increases b, and in this respect improves the lens. It indeed has diminished b', but this being already considerable, no inconvenience attends this diminution. But we learn, at the same time, that the advantage *must* be very small; for we cannot diminish a much more, without making it as small as the smallest radius of the object-glass. This proportion is therefore very near the maximum, or best possible; and we know that in such cases, even considerable changes in the radii will make but small changes in the result: for these reasons we are disposed to give a strong preference to the first construction, on account of the other advantages which we showed to attend it.

As another example, we may take a case which is very nearly the general practice of the London artists. The radius of curvature for the anterior surface of the convex crown-glass is $\frac{5}{6}$ths of the radius of the posterior surface, so that $h = \frac{5}{6}$. This being introduced into the determinate equation, gives

$$\begin{aligned} a &= 0.2938 \qquad & a' &= -0.3443 \\ b &= -0.3526 \qquad & b &= 1.1474 \end{aligned}$$

As another condition, we may suppose that the second or flint-glass is of a determined form.

This case is solved much in the same manner as the former. Taking h to represent the ratio of a' and b', we have $\frac{1}{a'} = \frac{1}{1-h}$. This value being substituted in the general equation $\frac{A}{a^2} - \frac{B}{a} - \frac{C}{a'2} - \frac{D}{a} + E = 0$, gives us $\frac{A}{a^2} - \frac{B}{a} + E - \frac{C}{(1-h)^2} - \frac{D}{1-h} = 0$. This gives for the final equation $x^2 + sx + t = 0$, $s = \frac{B}{A}$, and $t = \frac{1}{A} \times \left(E - \frac{C}{(1-h)^2} - \frac{D}{1-h}\right)$ and $\frac{1}{a} = -\frac{1}{2}\,\frac{1}{2}\,s \pm \sqrt{\frac{1}{4}s^2 - t}$.

We might here take the particular case of the flint-glass being equally concave on both sides. Then because $\frac{1}{n'}, = -u$, and in the case of equal concavities $\frac{2}{a'} = \frac{1}{n'}, = -u$, it is sufficient to put $-\frac{1}{2}u$ for $\frac{1}{a'}$. This being done, the equation becomes $\frac{A}{a} - \frac{B}{a}\,\frac{Cu^2}{4} + \frac{Du}{2} + E = 0$. This gives $s = \frac{B}{A}$, and $t = \frac{1}{A} \times \left(\frac{4Dn - 2Cu^2}{8} + E\right)$.

We imagine that these cases are sufficient for showing the management of the general equation; and the example of the numerical solution of the first case affords instances of the only niceties which occur in the process, viz. the proper employment of the positive and negative quantities.

We have oftener than once observed, that the formula is not perfectly accurate, and that in very large apertures errors will remain. It is proper therefore, when we have obtained the form of a compound object-glass, to calculate trigonometrically the progress of the light through it; and if we find a considerable aberration, either chromatic or spherical, remaining, we must make such changes in the curvatures as will correct them. We have done this for the first example; and we find, that if the focal distance of the compound object-glass be 100 inches, there remains of the spherical aberration nearly $\frac{1}{60}$th of an inch, and the aberration of colour is over corrected above $\frac{1}{9}$th of an inch. The first aberration has been diminished about 6 times, and the other about 30 times. Both of the remaining errors will be diminished by increasing the radius of the inner surfaces. This will diminish the aberration of the crown-glass, and will diminish the dispersion of the flint more than that of the crown. But indeed the remaining error is hardly worth our notice.

It is evident to any person conversant with optical discussions, that we shall improve the correction of the spherical aberration by diminishing the refractions. If we employ two lenses for producing the convergency of the rays to a real focus, we shall reduce the aberration to $\frac{1}{4}$th. Therefore a better achromatic glass will be formed of three lenses, two of which are convex and of crown-glass. The refraction being thus divided between them, the aberrations are lessened. There is no occasion to employ two concave lenses of flint-glass; there is even an advantage in using one. The aberration being considerable, less of it will serve for correcting the aberration of the crown glass, and therefore such a form may be selected as has little aberration. Some light is indeed lost by these two additional surfaces; but this is much more than compensated by the greater apertures which we can venture to give when the curvature of the surface is so much diminished. We proceed therefore to

The Construction of a Triple Achromatic Object-glass.

It is plain that there are more conditions to be assumed

sumed before we can render this a determinate problem, and that the investigation must be more intricate. At the same time, it must give us a much greater variety of constructions, in consequence of our having more conditions necessary for giving the equation this determinate form. Our limits will not allow us to give a full account of all that may be done in this method. We shall therefore content ourselves with giving one case, which will sufficiently point out the method of proceeding. We shall then give the results in some other eligible cases, as rules to artists by which they may construct such glasses.

Let the first and second glasses be of equal curvatures on both sides; the first being a double convex of crown-glass, and the second a double concave of flint-glass.

Still making n the unit of our calculus, we have in the first place $a = -b, = -a', = b'$. Therefore $\frac{1}{a'} - \frac{1}{b'} = -\left(\frac{1}{a} - \frac{1}{b}\right)$, or $\frac{1}{n'} = -\frac{1}{n} = -1$. Therefore the equation $\frac{m}{n} + \frac{dm'}{n'} + \frac{dm''}{n''} = 0$ becomes $u - 1 + \frac{u}{u''} = 0$, or $\frac{1}{n} = \frac{1}{u} - 1$. Let us call this value u'.

We have $\frac{1}{p} = m - 1$; $\frac{1}{p'} = -(m' - 1)$; $\frac{1}{p''} = u'(m-1)$; $\frac{1}{P} = \frac{1}{p} + \frac{1}{p'} + \frac{1}{p''}, = m - m' + u'(m-1)$. And if we make $m' - m = C$, we shall have $\frac{1}{P} = -C, + u'(m=1)$. Also $\frac{1}{r'} = m - 1$; $\frac{1}{r''} = m - 1 - (m' - 1), = m - m', = -C'$.

The equality of the two curvatures of each lens gives $\frac{1}{a} = \frac{1}{2n}$. Therefore $\frac{1}{a} = -\frac{1}{b'}, = -\frac{1}{a'}, = \frac{1}{b'} = \frac{1}{2}$; and $\frac{1}{b''} = \frac{1}{a''} - \frac{1}{n''}, = \frac{1}{a''} - u$.

Substituting these values in the equation (p. 252. col. 2. par. 1.), we obtain the three formulæ.

$$1. \quad cm^2 - \tfrac{1}{2}c(2m+1) + \frac{c(m+2)}{4m}$$

$$2. -m'2 + \tfrac{1}{2}(2m'+1) - \frac{m'+2}{4m'} + (3m'+1)(m-1) - \frac{2(m'+1)(m-1)}{m'} - \frac{(3m'+2)(m-1)^2}{m'}$$

$$3. cu'\,3m^2 - \frac{cu'^2(2m+1)}{a''} + \frac{cu'(m+2)}{ma''^2} - cc'u'^2(3m+1) + \frac{4cc'u'(m+1)}{ma''} + \frac{cc'^2u'(3m+2)}{m} = 0.$$

Now arrange these quantities according as they are coefficients of $\frac{1}{a''^2}$ and of $\frac{1}{a''}$, or independent quantities.

Let the coefficient of $\frac{1}{a''^2}$ be A, that of $\frac{1}{a''}$ be B, and the independent quantity be C, we have $A = \frac{cu'(m+2)}{m}$; $B = cu'^2(2m+1) - \frac{4cc'u'(m+1)}{m}$, and $C = cm^2 + \frac{c(m+2)}{4m} + \frac{1}{2}(2m'+1) + (3m'+1)(m-1) + cu'^3m^2 + \frac{cc'^2u'(3m+2)}{m} - \frac{1}{2}c(2m+1) - m'^2 - \frac{m'+2}{4m} - \frac{2(m'+1)(m-1)}{m'} - \frac{(3m'+2)(m-1)^2}{m'} - cc'u'^2(3m+1)$.

Our equation now becomes $\frac{A}{a''^2} - \frac{B}{a''} + C = 0$.

This reduced to numbers, by computing the values of the coefficients, is $\frac{1.312}{a''^2} - \frac{1.207}{a''} - 0.3257 = 0$.

This, divided by 1.312, gives $s = -0.92$; and $t = -0{,}2482$; $-\frac{1}{2}s = 0.46$; $\frac{1}{4}s^2 = 0.2116$; and $\sqrt{\frac{1}{4}s^2 - t} = \pm 0.6781$.

And, finally, $\frac{1}{a''} = 0.46 \pm 0.6781$.

This has two roots, viz. 0.2181 and $-$ 1.1381. The last would give a small radius, and is therefore rejected.

Now, proceeding with this value of $\frac{1}{a''}$ and the $\frac{1}{n''}$, we get the other radius b'', and then, by means of u', we get the other radius which is common to the four surfaces. Then, by $\frac{1}{P} = \frac{1}{p''} - c'$, we get the value of P.

The radii being all on the scale of which u is the unit, they must be divided by P to obtain their value on the scale which has P for its unit. This will give us

$a = -b, = -a', = b',$	$=0.530$
$a'' =$	1.215
$b'' =$	-0.3046
P=	1.

This is not a very good form, because the last surface has too great curvature.

We thought it worth while to compute the curvatures for a case where the internal surfaces of the lenses coincide, in order to obtain the advantages mentioned on a former occasion. The form is as follows:

The middle lens is a double concave of flint-glass; the last lens is of crown-glass, and has equal curvatures on both sides. The following table contains the dimensions of the glasses for a variety of focal distances. The first column contains the focal distances in inches; the second contains the radii of the first surface in inches; the third contains the radii of the posterior surface of the first lens and anterior surface of the second; and the fourth column has the radii of the three remaining surfaces.

P	a	b, a'	b', a'', b''
12	9.25	6.17	12.75
24	18.33	12.25	25.5
36	27.33	18.25	38.17
48	36.42	24.33	50.92
60	45.42	30.33	63.58
72	54.5	36.42	76.33
84	63.5	42.5	89.
96	72.6	48.5	101.75
108	81.7	54.58	114.42
120	90.7	60.58	127.17

We have had an opportunity of trying glasses of this construction, and found them equal to any of the same length, although executed by an artist by no means excellent in his profession as a glass-grinder. This very circumstance

Telescope. circumstance gave us the opportunity of seeing the good effects of interposing a transparent substance between the glasses. We put some clear turpentine varnish between them, which completely prevented all reflection from the internal surfaces. Accordingly these telescopes were surprisingly bright; and although the roughness left by the first grinding was very perceptible by the naked eye before the glasses were put together, yet when joined in this manner it entirely disappeared, even when the glasses were viewed with a deep magnifier.

The aperture of an object-glass of this construction of 30 inches focal distance was $3\frac{1}{5}$th inches, which is considerably more than any of Mr Dollond's that we have seen.

If we should think it of advantage to make all the three lenses isosceles, that is, equally curved on both surfaces, the general equation will give the following radii:

$$a = +0.639 \quad a' = -0.5285 \quad a'' = +0.6413$$
$$b = -0.639 \quad b' = +0.5285 \quad b'' = -0.6413$$

This seems a good form, having large radii.

Should we choose to have the two crown-glass lenses isosceles and equal, we must make

$$a = +0.6412 \quad a' = -0.5227 \quad a'' = +0.6412$$
$$b = -0.6412 \quad b' = +0.5367 \quad b'' = -0.6412$$

This form hardly differs from the last.

Our readers will recollect that all these forms proceed on certain measures of the refractive and dispersive powers of the substances employed, which are expressed by m, m', $d\,m$, and $d\,m'$: and we may be assured that the formulæ are sufficiently exact, by the comparison (which we have made in one of the cases) of the result of the formula and the trigonometrical calculation of the progress of the rays. The error was but $\frac{1}{60}$th of the whole, ten times less than another error, which unavoidably remains, and will be considered presently. These measures of refraction and dispersion were carefully taken; but there is great diversity, particularly in the flint-glass. We are well informed that the manufacture of this article has considerably changed of late years, and that it is in general less refractive and less dispersive than formerly. This must evidently make a change in the forms of achromatic glasses. The proportion of the focal distance of the crown-glasses to that of the flint must be increased, and this will occasion a change in the curvatures, which shall correct the spherical aberration. We examined with great care a parcel of flint-glass which an artist of this city got lately for the purpose of making achromatic object-glasses, and also some very white crown glass made in Leith; and we obtained the following measures:

$$m = 1.529 \qquad \frac{d\,m}{d\,m'} = \frac{142}{219} = 0.64841.$$
$$m' = 1.578$$

We computed some forms for triple object-glasses made of these glasses, which we shall subjoin as a specimen of the variations which this change of data will occasion.

If all the three lenses are made isosceles, we have

$$a = +0.796 \quad a' = -0.474 \quad a'' = +0.502$$
$$b = -0.796 \quad b' = +0.474 \quad b'' = -0.502$$

Or

$$a = 0.504 \quad a' = -0.475 \quad a'' = +0.793$$
$$b = -0.504 \quad b' = 0.475 \quad b'' = -0.793$$

If the middle lens be isosceles, the two crown-glass lenses may be made of the same form and focal distance, and placed the same way. This will give us

$$a = +0.705 \quad a' = -0.475 \quad a'' = +0.705$$
$$b = -0.547 \quad b' = +0.475 \quad b'' = -0.547$$

N. B. This construction allows a much better form, if the measures of refraction and dispersion are the same that we used formerly. For we shall have

$$a = +0.628 \quad a' = -0.579 \quad a'' = +0.628$$
$$b = -0.749 \quad b' = +0.579 \quad b'' = -0.749$$

And this is pretty near the practice of the London opticians.

We may here observe, upon the whole, that an amateur has little chance of succeeding in these attempts. The diversity of glasses, and the uncertainty of the workman's producing the very curvatures which he intends, is so great, that the object-glass turns out different from our expectation. The artist who makes great numbers acquires a pretty certain guess at the remaining error; and having many lenses, intended to be of one form, but unavoidably differing a little from it, he tries several of them with the other two, and finding one better than the rest, he makes use of it to complete the set.

The great difficulty in the construction is to find the exact proportion of the dispersive powers of the crown and flint-glass. The crown is pretty constant; but there are hardly two pots of flint-glass which have the same dispersive power. Even if constant, it is difficult to measure it accurately; and an error in this greatly affects the instrument, because the focal distances of the lenses must be nearly as their dispersive powers. The method of examining this circumstance, which we found most accurate, was as follows:

The sun's light, or that of a brilliant lamp, passed through a small hole in a board, and fell on another board pierced also with a small hole. Behind this was placed a fine prism A (fig. 14.), which formed a spectrum ROV on a screen pierced with a small hole. Behind this was placed a prism B of the substance under examination. The ray which was refracted by it fell on the wall at D, and the distance of its illumination from that point to C, on which an unrefracted ray would have fallen, was carefully measured. This showed the refraction of that colour. Then, in order that we might be certain that we always compared the refraction of the same precise colour by the different prisms placed at B, we marked the precise position of the prism A when the ray of a particular colour fell on the prism B. This was done by an index AG attached to A, and turning with it, when we caused the different colours of the spectrum formed by A to fall on B. Having examined one prism B with respect to all the colours in the spectrum formed by A, we put another B in its place. Then bringing A to all its former positions successively, by means of a graduated arch HGK, we were certain that when the index was at the same division of the arch it was the very ray which had been made to pass through the first prism B in a former experiment. We did not solicitously endeavour to find the very extreme red and violet rays; because, although we did not learn the whole dispersions of the two prisms, we learned their proportions, which is the circumstance wanted in the construction of achroma- Fig. 14.

Telescope. tic glasses. It is in vain to attempt this by measuring the spectrums themselves; for we cannot be certain of selecting the very same colours for the comparison, because they succeed in an insensible gradation.

The intelligent reader will readily observe, that we have hitherto proceeded on the supposition, that when, by means of contrary refractions, we have united the extreme red and violet rays, we have also united all the others. But this is quite gratuitous. Sir Isaac Newton would, however, have made the same supposition; for he imagined that the different colours divided the spectrum formed by all substances in the proportions of a musical canon. This is a mistake. When a spectrum is formed by a prism of crown glass, and another of precisely the same length is formed by the side of it by a prism of flint glass, the confine between the green and blue will be found precisely in the middle of the first spectrum, but in the second it will be considerably nearer to the red extremity. In short, different substances do not disperse the colours in the same proportion.

The effect of this irrationality (so to call it) of dispersion, will appear plainly, we hope, in the following manner: Let A (fig. 12.) represent a spot of white solar light falling perpendicularly on a wall. Suppose a prism of common glass placed behind the hole through which the light is admitted, with its refracting angle facing the left hand. It will refract the beam of light to the right, and will at the same time disperse this heterogeneous light into its component rays, carrying the extreme red ray from A to R, the extreme orange from A to O, the extreme yellow from A to Y, &c. and will form the usual prismatic spectrum ROYGBPVC. If the whole length RC be divided into 1000 parts, we shall have (when the whole refraction AR is small) RO very nearly 125, RY=200, RG=333, RB=500 RP=667, RV=778, and RC=1000; this being the proportion observed in the differences of the sines of refraction by Sir Isaac Newton.

Fig. 12.

Perhaps a refracting medium may be found such, that a prism made of it would refract the white light from A′, in the upper line of this figure, in such a manner that a spectrum R′O′Y′G′B′P′V′C′ shall be formed at the same distance from A′, and of the same length, but divided in a different proportion. We do not know that such a medium has been found; but we know that a prism of flint-glass has its refractive and dispersive powers so constituted, that if A′H be taken about one-third of AR, a spot of white light, formed by rays falling perpendicularly at H′, will be so refracted and dispersed that the extreme red ray will be carried from H′ to R′, and the extreme violet from H′ to C′, and the intermediate colours to intermediate points, forming a spectrum resembling the other, but having the colours more constipated towards R′, and more dilated towards C; so that the ray which the common glass carried to the middle point B of the spectrum RC is now in a point B′ of the spectrum R′C′, considerably nearer to R′.

Dr Blair has found, on the other hand, that certain fluids, particularly such as contain the muriatic acid, when formed into a prism, will refract the light from H″ (in the lower line) so as to form a spectrum R″C″ equal to RC, and as far removed from A″ as RC is from A, but having the colours more dilated toward R″, and more constipated toward C, than is observed in RC; so that the ray which was carried by the prism of common glass to the middle point B, is carried to a point B″ considerably nearer to C″.

Telescope.

Let us now suppose that, instead of a white spot at A, we have a prismatic spectrum AB (fig. 13.), and that the prism of common glass is applied as before, immediately behind the prism which forms the spectrum AB. We know that this will be refracted sidewise, and will make a spectrum ROYGBPC, inclined to the plane of refraction in an angle of 45°; so that drawing the perpendicular RC′, we have RC′=C′C.

Fig. 13.

We also know that the prism of flint-glass would refract the spectrum formed by the first prism on EHF, in such a manner that the red ray will go to R, the violet to C, and the intermediate rays to points *o*, *y*, *g*, *b*, *p*, *v*, so situated that O′*o* is = R′O′ of the other figure; Y*y* is = R′Y′ of that figure, G*g* = R′G′, &c. These points must therefore lie in a curve R *o y g b p v* C, which is convex towards the axis R′C′.

In like manner we may be assured that Dr Blair's fluid will form a spectrum R *o′ y′ g′ b′ p′ v′* C, concave toward R′C.

Let it be observed by the way, that this is a very good method for discovering whether a medium disperses the light in the same proportion with the prism which is employed for forming the first spectrum AB or EF. It disperses in the same or in a different proportion, according as the oblique spectrum is straight or crooked; and the exact proportion corresponding to each colour is had by measuring the ordinates of the curves R *b* C or R *b′* C.

Having formed the oblique spectrum RBC by a prism of common glass, we know that an equal prism of the same glass, placed in a contrary position, will bring back all the rays from the spectrum RBC to the spectrum AB, laying each colour on its former place.

In like manner, having formed the oblique spectrum R *b* C by a prism of flint-glass, we know that another prism of flint-glass, placed in the opposite direction, will bring all the rays back to the spectrum EHF.

But having formed the oblique spectrum RBC by a prism of common glass, if we place the flint-glass prism in the contrary position, it will bring the colour R back to E, and the colour C to F; but it will not bring the colour B to H, but to a point *h*, such that B *h* is equal to *b* H, and *b* B to *h* H. In like manner, the other colours will not be brought back to the straight line EHF, but to a curve E *h* F, forming a crooked spectrum.

In like manner, the fluids discovered by Dr Blair, when employed to bring back the oblique spectrum RBC formed by common glass will bring its extremities back to E and F, and form the crooked spectrum E *h′* F lying beyond EHF.

This experiment evidently gives us another method for examining the proportionality of the dispersion of different substances.

Having, by common glass, brought back the oblique spectrum formed by common glass to its natural place AB, suppose the original spectrum at AB to contract gradually (as Newton has made it to do by means of a lens), it is plain that the oblique spectrum will also contract, and so will the second spectrum at AB; and it will at last coalesce into a white spot. The effect will be equivalent to a gradual compression of the whole figure, Telescope. figure, by which the parallel lines AR and BC gradually approach, and at last unite.

In like manner, when the oblique spectrum formed by flint-glass is brought back to EHF by a flint-glass prism, and the figure compressed in the same gradual manner, all the colours will coalesce into a white spot.

But when flint-glass is employed to bring back the oblique spectrum formed by common glass, it forms the crooked spectrum E *h* F. Now let the figure be compressed. The curve E *h* F will be doubled down on the line H *h*, and there will be formed a compound spectrum H *h*, quite unlike the common spectrum, being purple or claret-coloured at H by the mixture of the extreme red and violet, and green edged with blue at *h* by the mixture of the green and blue. The fluid prisms would in like manner form a spectrum of the same kind on the other side of H.

This is precisely what is observed in achromatic object-glasses made of crown-glass and flint: for the refraction from A to R corresponds to the refraction of the convex crown-glass; and the contrary refraction from R to E corresponds to the contrary refraction of the concave flint-glass, which still leaves a part of the first refraction, producing a convergence to the axis of the telescope. It is found to give a purple or wine-coloured focus, and within this a green one, and between these an imperfect white. Dr Blair found, that when the eye-glass was drawn out beyond its proper distance, a star was surrounded by a green fringe, by the green end of the spectrum, which crossed each other within the focus; and when the eye-glass was too near the object-glass, the star had a wine-coloured fringe. The green rays were ultimately most refracted. *N. B.* We should expect the fringe to be of a blue colour rather than a green. But this is easily explained: The extreme violet rays are very faint, so as hardly to be sensible; therefore when a compound glass is made as achromatic as possible to our senses, in all probability (nay certainly) these almost insensible violet rays are left out, and perhaps the extreme colours which are united are the red and the middle violet rays. This makes the green to be the mean ray, and therefore the most outstanding when the dispersions are not proportional.

Dr Blair very properly calls these spectrums, H *h* and H *h'*, *secondary spectrums*, and seems to think that he is the first who has taken notice of them. But Mr Clairault was too accurate a mathematician, and too careful an observer, not to be aware of a circumstance which was of primary consequence to the whole inquiry. He could not but observe that the success rested on this very particular, and that the proportionality of dispersion was indispensably necessary.

This subject was therefore touched on by Clairault; and *fully* discussed by Boscovich, first in his Dissertations published at Vienna in 1759; then in the *Comment. Bononiensis;* and, lastly, in his *Opuscula*, published in 1785. Dr Blair, in his ingenious Dissertation on Achromatic Glasses, read to the Royal Society of Edinburgh in 1793, seems not to have known of the labours of these writers; speaks of it as a new discovery; and exhibits some of the consequences of this principle in a singular point of view, as something very paradoxical and inconsistent with the usually received notions on these subjects. But they are by no means so. We are, however, much indebted to his ingenious researches, and his successful endeavours to find some remedy for this imperfection of achromatic glasses. Some of his contrivances are exceedingly ingenious; but had the Doctor consulted these writers, he would have saved himself a good deal of trouble.

Boscovich shows how to unite the two extremes with the most outstanding colour of the secondary spectrum, by means of a third substance. When we have done this, the aberration occasioned by the secondary spectrums must be prodigiously diminished; for it is evidently equivalent to the union of the points H and *h* of our figure. Whatever cause produces this must diminish the curvature of the arches E *h* and *h* F: but even if these curvatures were not diminished, their greatest ordinates cannot exceed one-fourth of H *h*; and we may say, without hesitation, that by uniting the mean or most outstanding ray with the two extremes, the remaining dispersion will be as much less than the uncorrected colour of Dollond's achromatic glass, as this is less than four times the dispersion of a common object-glass. It must therefore be altogether insensible.

Boscovich asserts, that it is not possible to unite more than two colours by the opposite refraction of two substances, which do not disperse the light in the same proportions. Dr Blair makes light of this assertion, as he finds it made in general terms in the vague and paltry extract made by Priestley from Boscovich in his Essay on the History of Optics; but had he read this author in his own dissertations, he would have seen that he was perfectly right. Dr Blair, however, has hit on a very ingenious and effectual method of producing this union of three colours. In the same way as we correct the dispersion of a concave lens of crown-glass by the opposite dispersion of a concave lens of flint-glass, we may correct the secondary dispersion of an achromatic convex lens by the opposite secondary dispersion of an achromatic concave lens. But the intelligent reader will observe, that this union does not contradict the assertion of Boscovich, because it is *necessarily* produced by means of three refracting substances.

The most essential service which the public has received at the hands of Dr Blair is the discovery of fluid mediums of a proper dispersive power. By composing the lenses of such substances, we are at once freed from the irregularities in the refraction and dispersion of flint-glass, which the chemists have not been able to free it from. In whatever way this glass is made, it consists of parts which differ both in refractive and dispersive power; and when taken up from the pot, these parts mix in threads, which may be disseminated through the mass in any degree of fineness. But they still retain their properties; and when a piece of flint-glass has been formed into a lens, the eye, placed in its focus, sees the whole surface occupied by glistening threads or broader veins running across it. Great rewards have been offered for removing this defect, but hitherto to no purpose. We beg leave to propose the following method: Let the glass be reduced to powder, and then melted with a great proportion of alkaline salt, so as to make a liquor silicum. When precipitated from this by an acid, it must be in a state of very uniform composition. If again melted into glass we should hope that it would be free from this defect; if not, the case seems to be desperate.

But by using a fluid medium, Dr Blair was freed from all this embarrassment; and he acquired another

Telescope. immense advantage, that of adjusting at pleasure both the refractive and dispersive powers of his lenses. In solid lenses, we do not know whether we have taken the curvatures suited to the refractions till our glass is finished; and if we have mistaken the proportions, all our labour is lost. But when fluids are used, it is enough that we know nearly the refractions. We suit our focal distances to these, and then select our curvature, so as to remove the aberration of figure, preserving the focal distances. Thus, by properly tempering the fluid mediums, we bring the lens to agree precisely with the theory, perfectly achromatic, and the aberration of figure as much corrected as is possible.

Dr Blair examined the refractive and dispersive powers of a great variety of substances, and found great varieties in their actions on the different colours. This is indeed what every well informed naturalist would expect. There is no doubt now among naturalists about the mechanical connection of the phenomena of nature; and all are agreed that the chemical actions of the particles of matter are perfectly like in kind to the action of gravitating bodies; that all these phenomena are the effects of forces like those which we call attractions and repulsions, and which we observe in magnets and electrified bodies; that light is refracted by forces of the same kind, but differing chiefly in the small extent of their sphere of activity. One who views things in this way will expect, that as the actions of the same acid for the different alkalies are different in degree, and as the different acids have also different actions on the same alkali, in like manner different substances differ in their general refractive powers, and also in the proportion of their action on the different colours. Nothing is more unlikely therefore than the proportional dispersion of the different colours by different substances; and it is surprising that this inquiry has been so long delayed. It is hoped that Dr Blair will oblige the public with an account of the experiments which he has made. This will enable others to co-operate in the improvement of achromatic glasses. We cannot derive much knowledge from what he has already published, because it was chiefly with the intention of giving a popular, though not an accurate, view of the subject. The constructions which are there mentioned are not those which he found most effectual, but those which would be most easily understood, or demonstrated by the slight theory which is contained in the dissertation; besides, the manner of expressing the difference of refrangibility, perhaps chosen for its paradoxical appearance, does not give us a clear notion of the characteristic differences of the substances examined. Those rays which are ultimately most deflected from their direction, are said to have become the most refrangible by the combination of different substances, although, in all the particular refractions by which this effect is produced, they are less refracted than the violent light. We can just gather this much, that common glass disperses the rays in such a manner, that the ray which is in the confine of the green and blue occupies the middle of the prismatic spectrum; but in glasses, and many other substances, which are more dispersive, this ray is nearer to the ruddy extremity of the spectrum. While therefore the straight line RC′ (fig. 13.) terminates the ordinates O*o*′, YY′, G*g*′, &c. which represent the dispersion of common glass, the ordinates which express the dispersions of these substances

Fig. 13.

are terminated by a curve passing through R and C′, but lying below the line RC′. When therefore parallel heterogeneous light is made to converge to the axis of a convex lens of common glass, as happens at F in fig. 6. C, the light is dispersed, and the violet rays have a shorter focal distance. If we now apply a concave lens of greater dispersive power, the red and violet rays are brought to one focus F; but the green rays, not being so much refracted away from F, are left behind at φ, and have now a shorter focal distance. But Dr Blair afterwards found that this was not the case with the muriatic acid, and some solutions in it. He found that the ray which common glass caused to occupy the middle of the spectrum was much nearer to the blue extremity when refracted by these fluids. Therefore a concave lens formed of such fluids which united the red and violet rays in F′, refracted the green rays to *f*′.

Fig. 6.

Having observed this, it was an obvious conjecture, that a mixture of some of these fluids might produce a medium, whose action on the intermediate rays should have the same proportion that is observed on common glass; or that two of them might be found which formed spectra similarly divided, and yet differing sufficiently in dispersive power to enable us to destroy the dispersion by contrary refractions, without destroying the whole refraction. Dr Blair accordingly found a mixture of solutions of ammoniacal and mercurial salts, and also some other substances, which produced dispersions proportional to that of glass, with respect to the different colours.

And thus has the result of this intricate and laborious investigation corresponded to his utmost wishes. He has produced achromatic telescopes which seem as perfect as the thing will admit of; for he has been able to give them such apertures, that the *incorrigible* aberration arising from the spherical surfaces becomes a sensible quantity, and precludes farther amplification by the eye-glasses. We have examined one of his telescopes: The focal distance of the object-glass did not exceed 17 inches, and the aperture was fully 3½ inches. We viewed some single and double stars and some common objects with this telescope; and found, that in magnifying power, brightness, and distinctness, it was manifestly superior to one of Mr Dollond's of 42 inches focal length. It also gave us an opportunity of admiring the dexterity of the London artists, who could work the glasses with such accuracy. We had most distinct vision of a star when using an erecting eye-piece, which made this telescope magnify more than a hundred times; and we found the field of vision as uniformly distinct as with Dollond's 42 inch telescope magnifying 46 times. The intelligent reader must admire the nice figuring and centering of the very deep eye-glasses which are necessary for this amplification.

It is to be hoped that Dr Blair will extend his views to *glasses* of different compositions, and thus give us object-glasses which are solid; for those composed of fluids have inconveniences which will hinder them from coming into general use, and will confine them to the museums of philosophers. We imagine that antimonial glasses bid fair to answer this purpose, if they could be made free of colour, so as to transmit enough of light. We recommend this dissertation to the careful perusal of our readers. Those who have not made themselves much acquainted with the delicate and abstruse theory of aberrations, will find it exhibited in such a popular form

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form as will enable them to understand its general aim; and the well-informed reader will find many curious indications of inquiries and discoveries yet to be made.

We now proceed to consider the eye-glasses or glasses of telescopes. The proper construction of an eye-piece is not less essential than that of the object-glass. But our limits will not allow us to treat this subject in the same detail. We have already extended this article to a great length, because we do not know of any performance in the English language which will enable our readers to understand the construction of achromatic telescopes; an invention which reflects honour on our country, and has completed the discoveries of our illustrious Newton. Our readers will find abundant information in Dr Smith's Optics concerning the eye-glasses, chiefly deduced from Huyghen's fine theory of aberration (A). At the same time, we must again pay Mr Dollond the merited compliment of saying, that he was the first who made any scientific application of this theory to the compound eye-piece for erecting the object. His eye-pieces of five and six glasses are very ingenious reduplications of Huyghen's eye-pieces of two glasses, and would probably have superseded all others, had not his discovery of achromatic object-glasses caused opticians to consider the chromatic dispersion with more attention, and pointed out methods of correcting it in the eye-piece without any compound eye-glasses. They have found that this may be more conveniently done with four eye-glasses, without sensibly diminishing the advantages which Huyghens showed to result from employing many small refractions instead of a lesser number of great ones. As this is a very curious subject, we shall give enough for making our readers fully acquainted with it, and content ourselves with merely mentioning the principles of the other rules for constructing an eye-piece.

Such readers as are less familiarly acquainted with optical discussions will do well to keep in mind the following consequences of the general focal theorem.

Fig. 15. If AB (fig. 15.) be a lens, R a radiant point or focus of incident rays, and a the focus of parallel rays coming from the opposite side; then,

1. Draw the perpendicular $a\,a'$ to the axis, meeting the incident ray in a', and a' A to the centre of the lens. The refracted ray BF is parallel to a' A; for R a' : a' A (= R a : a A) = RB : BF (=RA : AF), which is the focal theorem.

2. An oblique pencil BP b proceeding from any point P which is not in the axis, is collected to the point f, where the refracted ray BF cuts the line PA f drawn from P through the centre of the lens: for P a': a' A = PB : B f, which is also the focal theorem.

The Galilean telescope is susceptible of so little improvement that we need not employ any time in illustrating its performance.

Telescope.

The simple astronomical telescope is represented in fig. 16. The beam of parallel rays, inclined to the axis, is made to converge to a point G where it forms an image of the lowest point of a very distant object. These rays decussating from G fall on the eye-glass; the ray from the lowest point B of the object-glass falls on the eye-glass at b; and the ray from A falls on a; and the ray from the centre O falls on o. These rays are rendered parallel, or nearly so, by refraction through the eye-glass, and take the direction $b\,i'$, o I, $a\,i$. If the eye be placed so that this pencil of parallel rays may enter it, they converge to a point of the retina, and give distinct vision to the lowest point of the object. It appears inverted, because the rays by which we see its lowest point come in the direction which in simple vision is connected with the upper point of an object. They come from above, and therefore are thought to proceed from above. We see the point as if situated in the direction I o. In like manner the eye placed at I, sees the upper point of the object in the direction IP, and its middle in the direction IE. The proper place for the eye is I; if brought much nearer the glass, or removed much farther from it, some, or the whole, of this extreme pencil of rays will not enter the pupil. It is is therefore of importance to determine this point. Because the eye requires parallel rays for distinct vision, it is plain that F must be the principal focus of the eye-glass. Therefore, by the common focal theorem, OF : OE = OE : OI, or OF : FE = OE : EI. Fig. 16.

The magnifying power being measured by the magnitude of the visual angle, compared with the magnitude of the visual angle with the naked eye, we have $\frac{o\,I\,p}{o\,O\,p}$, or $\frac{o\,IF}{o\,OF}$ for the measure of the magnifying power. This is very nearly $= \frac{OE}{EI}$ or, $\frac{OF}{FI}$.

As the line OE, joining the centres of the lenses, and perpendicular to their surfaces, is called the axis of the telescope, so the ray OG is called the axis of the oblique pencil, being really the axis of the cone of light which has the object-glass for its base. This ray is through its whole course the axis of the oblique pencil; and when its course is determined, the amplification, the field of vision, the apertures of the glasses, are all determined. For this purpose we have only to consider the centre of the object-glass as a radical point, and trace the process of a ray from this point through the other glasses: this will be the axis of some oblique pencil.

It is evident, therefore, that the field of vision depends on the breadth of the eye-glass. Should we increase this, the extreme pencil will pass through I, because O and I are still the conjugate foci of the eye-glass.

(A) While we thus repeatedly speak of the theory of spherical aberration as coming from Mr Huyghens, we we must not omit giving a due share of the honour of it to Dr Barrow and Mr James Gregory. The first of these authors, in his Optical Lectures delivered at Cambridge, has given every proposition which is employed by Huyghens, and has even prosecuted the matter much further. In particular, his theory of oblique slender pencils is of immense consequence to the perfection of telescopes, by showing the methods for making the image of an extended surface as flat as possible. Gregory, too, has given all the fundamental propositions in his *Optica Promota*. But Huyghens, by taking the subject together, and treating it in a system, has greatly simplified it: and his manner of viewing the principal parts of it is incomparably more perspicuous than the performances of Barrow and Gregory.

Telescope.

glass. On the other hand, the angle resolved on for the extent or field of vision gives the breadth of the eye-glass.

We may here observe, by the way, that for all optical instruments there must be two optical figures considered. The first shows the progress of a pencil of rays coming from one point of the object. The various focuses of this pencil show the places of the different images, real or virtual. Such a figure is formed by the three rays AG *a i*, OG *o* I, BG *b i*.

The second shows the progress of the axes of the different pencils proceeding through the centre of the object-glass. The focuses of this pencil of axes show the places where an image of the object glass is formed; and this pencil determines the field of vision, the apertures of the lenses, and the amplification or magnifying power. The three rays OG *o* I, OFEI, OHPI, form this figure.

See also fig. 24. where the progress of both sets of pencils is more diversified.

The perfection of a telescope is to represent an object in its proper shape, distinctly magnified, with a great field of vision, and sufficiently bright. But there are limits to all these qualities; and an increase of one of them, for the most part, diminishes the rest. The brightness depends on the aperture of the object-glass, and will increase in the same proportion (because *i i'* will always be to AB in the proportion of EF to FO), till the diameter of the emergent pencil is equal to that of the pupil of the eye. Increasing the object-glass any more, can send no more light into the eye. But we cannot make the emergent pencil nearly so large as this when the telescope magnifies much; for the great aperture of the object-glass produces an indistinct image at GF, and its indistinctness is magnified by the eye-glass.

A great field of vision is incompatible with the true shape of the object; for it is not strictly true that all rays flowing from O are refracted to I. Those rays which go to the margin of the eye glass cross the axis between E and I; and therefore they cross it at a greater angle than if they passed through I. Now had they really passed through I, the object would have been represented in its due proportions. Therefore since the angles of the marginal parts are enlarged by the aberration of the eye-glass, the marginal parts themselves will appear enlarged, or the object appear distorted. Thus a chess-board viewed through a reading glass appears drawn out at the corners, and the straight lines are all changed into curves, as is represented in fig. 18. Fig. 18.

The circumstance which most peremptorily limits the extent of field is the necessary distinctness. If the vision be indistinct, it is useless, and no other quality can compensate this defect. The distortion is very inconsiderable in much larger angles of vision than we can admit, and is unworthy of the attention paid to it by optical writers. They have been induced to take notice of it, because the means of correcting it in a considerable degree are attainable, and afford an opportunity of exhibiting their knowledge; whereas the indistinctness which accompanies a large field is a subject of most difficult discussion, and has hitherto baffled all their efforts to express by any intelligible or manageable formulæ.

Quæque tractata nitescere posse
Desperat relinquit.

This subject must, however be considered. The image at GF of a very remote object is not a plain surface perpendicular to the axis of the telescope, but is nearly spherical, having O for its centre. If a number of pencils of parallel rays crossing each other in I fall on the eye-glass, they will form a picture on the opposite side, in the focus F. But this picture will by no means be flat, nor nearly so, but very concave towards E. Its exact form is of most difficult investigation. The elements of it are given by Dr Barrow; and we have given the chief of them in the article OPTICS, when considering the foci of infinitely slender pencils of oblique rays. Therefore it is impossible that the picture formed by the object-glass can be seen distinctly in all its parts by the eye-glass. Even if it were flat, the points G and H (fig. 16.) are too far from the eye-glass when the middle F is at the proper distance for distinct vision. When, therefore, the telescope is so adjusted that we have distinct vision of the middle of the field, in order to see the margin distinctly we must push in the eye-glass: and having so done, the middle of the field becomes indistinct. When the field of vision exceeds 12 or 15 degrees, it is not possible by any contrivance to make it tolerably distinct all over; and we must turn the telescope successively to the different parts of the field that we may see them agreeably. Fig. 16.

The cause of this indistinctness is, as we have already said, the shortness of the lateral foci of lateral and oblique pencils refracted by the eye-glass. The oblique pencil *b* G *a*, by which an eye placed at I sees the point G of the image, is a cone of light, having a circular base on the eye-glass; of which circle *a b* is one of the diameters. There is a diameter perpendicular to this, which, in this figure, is represented by the point *o*. Fig. 17. represents the base of the cone as seen by an eye placed in the axis of the telescope, with the object-glass as appearing behind it. The point *b* is formed by a ray which comes from the lowest point B of the object-glass, and the point *a* is illuminated by a ray from A. The point *c* at the right hand of the circular base of this cone of light came from the point C on the left side of the object-glass; and the light comes to *d* from D. Now the laws of optics demonstrate, that the rays which come through the points *c* and *d* are more convergent after refraction than the rays which come through *a* and *b*. The analogies, therefore, which ascertain the foci of rays lying in planes passing through the axis do not determine the foci of the others. Of this we may be sensible by looking through a lens to a figure on which are drawn concentric circles crossed by radii. When the telescope is so adjusted that we see distinctly the extremity of one of the radii, we shall not see distinctly the circumference which crosses the extremity with equal distinctness, and *vice versa*. This difference, however, between the foci of the rays which come through *a* and *b*, and those which come through *c* and *d*, is not considerable in the fields of vision, which are otherwise admissible. But the same difference of foci obtains also with respect to the dispersion of light, and is more remarkable. Both d'Alembert and Euler have attempted to introduce it into their formulæ; Fig. 17.

Telescope. mulæ; but they have made them useless for any practical purpose by their inextricable complication.

This must serve as a general indication of the difficulties which occur in the construction of telescopes, even although the object-glass were perfect, forming an image without the smallest confusion or distortion.

There is yet another difficulty or imperfection. The rays of the pencil a G b, when refracted through the eye-glass, are also separated into their component colours. The edge of the lens must evidently perform the office of a prism, and the white ray G b will be so dispersed that if $b\,i$ be the path of its red ray, the violet ray, which makes another part of it, will take such a course $b\,n$ that the angle $i'\,b\,n$ will be nearly $\frac{1}{27}$th of G$'$ b i'. The ray G a passing through a part of the lens whose surfaces are less inclined to each other, will be less refracted, and will be less dispersed in the same proportion very nearly. Therefore the two violet rays will be very nearly parallel when the two red rays are rendered parallel.

Hence it must happen, that the object will appear bordered with coloured fringes. A black line seen near the margin on a white ground, will have a ruddy and orange border on the outside and a blue border within: and this confusion is altogether independent on the object-glass, and is so much the greater as the visual angle b IE is greater.

Such are the difficulties: They would be unsurmountable were it not that some of them are so connected that, to a certain extent, the diminution of one is accompanied by a diminution of the other. What are called the *caustic curves* are the geometrical loci of the foci of infinitely slender pencils. Consequently the point G is very nearly in the caustic formed by a beam of light consisting of rays parallel to I o, and occupying the whole surface of the eye-glass, because the pencil of rays which are collected at G is very small. Any thing therefore that diminishes the mutual inclination of the adjoining rays, puts their concourse farther off. Now this is precisely what we want: for the point G of the image formed by the object-glass is already beyond the focus of the oblique slender pencil of parallel rays $i\,a$ and $i'\,b$; and therefore, if we could make this focus go a little farther from a and b, we shall bring it nearer to G, and obtain more distinct vision of this point of the object. Now let it be recollected, that in moderate refractions through prisms, two rays which are inclined to each other in a small angle are, after refraction, inclined to each other in the same angle. Therefore, if we can diminish the aberration of the ray $a\,i$, or o I, or $b\,i'$, we diminish their mutual inclination; and consequently the mutual inclination of the rays G a, G o, Gb', and therefore lengthen the focus, and get more distinct vision of the point G. Therefore we at once correct the distortion and the indistinctness: and this is the aim of Mr Huyghen's great principle of dividing the refractions.

Fig. 19. The general method is as follows: Let o be the object-glass (fig 19.) and E the eye-glass of a telescope, and F their common focus, and FG the image formed by the object-glass. The proportion of their focal distances is supposed to be such as gives as great a magnifying power as the perfection of the object-glass will admit. Let BI be the axis of the emergent pencil. It is known by the focal theorem that GE is parallel to BI: therefore BGE is the whole refraction or deflection of the ray OHB from its former direction. Let it be proposed to diminish the aberrations by dividing this into two parts by means of two glasses D and e, so as to make the ultimate angle of vision $b\,i\,c$ equal to BIE, and thus retain the same magnifying power and visible field. Let it be proposed to divide it into the parts BGC and CGE.

From G draw any line GD to the axis towards O; and draw the perpendicular DH, cutting OG in H; draw H c parallel to GC, cutting GD in g; draw $g\,f$ perpendicular to the axis, and $g\,e$ parallel to GE; draw $e\,b$ perpendicular to the axis; draw D δ parallel to GC, and $d\,\delta$ perpendicular to the axis.

Then if there be placed at D a lens whose focal distance is D d, and another at e whose focal distance is $e\,f$, the thing is done. The ray OH will be refracted into H b, and this into $b\,i$, parallel to BI.

The demonstration of this construction is so evident by means of the common focal theorem, that we need not repeat it, nor the reasons for its advantages. We have the same magnifying power, and the same field of vision; we have less aberration, and therefore less distortion and indistinctness; and this is brought about by a lens HD of a smaller aperture and a greater focal distance than BE. Consequently, if we are contented with the distinctness of the margin of the field with a single eye-glass, we may greatly increase the field of vision; for if we increase DH to the size of EB we shall have a greater field, and much greater distinctness in the margin; because HD is of a longer focal distance, and will bear a greater aperture, preserving the same distinctness at the edge. On this account the glass HD is commonly called the *Field-glass*.

It must be observed here, however, that although the distortion of the object is lessened, there is a real distortion produced in the image $f\,g$. But this, when magnified by the glass e, is smaller than the distortion produced by the glass E, of greater aperture and shorter focus, on the undistorted image GF. But because there is a distortion in the second image $f\,g$, this construction cannot be used for the telescopes of astronomical quadrants, and other graduated instruments; because then equal divisions of the micrometer would not correspond to equal angles.

But the same construction will answer in this case by taking the point D on that side of F which is remote from O (fig. 20.). This is the form now employed in the telescopes of all graduated instruments.

The exact proportion in which the distortion and the indistinctness at the edges of the field are diminished by this construction, depends on the proportion in which the angle BGE is divided by GC; and is of pretty difficult investigation. But it never deviates far (never $\frac{1}{7}$th in optical instruments) from the proportion of the squares of the angles. We may, without any sensible error, suppose it in this proportion. This gives us a practical rule of easy recollection, and of most extensive use. When we would diminish an aberration by dividing the whole refraction into two parts, we shall do it most effectually by making them equal. In like manner, if we divide it into three parts by means of two additional

ditional glasses, we must make each $= \frac{1}{3}$ of the whole; and so on for a greater number.

This useful problem, even when limited, as we have done, to equal refractions, is as yet indeterminate; that is, susceptible of an infinity of solutions: for the point D, where the field-glass is placed, was taken at pleasure; yet there must be situations more proper than others. The aberrations which produce distortion, and those which produce indistinctness, do not follow the same proportions. To correct the indistinctness, we should not select such positions of the lens HD as will give a small focal distance to $b\,c$; that is, we should not remove it very far from F. Huyghens recommends the proportion of 3 to 1 for that of the focal distances of the lens HD and $e\,b$, and says that the distance D e should be $= 2$ F e. This will make $e\,i = \frac{1}{2}\,e$ F, and will divide the whole refraction into two equal parts, as any one will readily see by constructing the common optical figure. Mr Short, the celebrated improver of reflecting telescopes, generally employed this proportion; and we shall presently see that it is a very good one.

It has been already observed that the great refractions which take place on the eye-glasses occasion very considerable dispersions, and disturb the vision by fringing every thing with colours. To remedy this, achromatic eye-glasses may be employed, constructed by the rules already delivered. This construction, however, is incomparably more intricate than that of object-glasses: for the equations must involve the distance of the radiant point, and be more complicated: and this complication is immensely increased on account of the great obliquity of the pencils.

Most fortunately the Huyghenian construction of an eye-piece enables us to correct this dispersion to a great degree of exactness. A heterogeneous ray is dispersed at H, and the red ray belonging to it falls on the lens $b\,e$ at a greater distance from the centre than the violet ray coming from H. It will therefore be less refracted (*cæteris paribus*) by the lens $b\,e$; and it is possible that the difference may be such that the red and violet rays dispersed at H may be rendered parallel at b, or even a little divergent, so as to unite accurately with the red ray at the bottom of the eye. How this may be effected, by a proper selection of the places and figures of the lenses, will appear by the following proposition, which we imagine is new, and not inelegant.

Fig. 21. Let the compound ray OP (fig. 21.) be dispersed by the lens PC; and let PV, PR be its violet and red rays, cutting the axis in G and g. It is required to place another lens RD in their way, so that the emergent rays R r, V v, shall be parallel.

Produce the incident ray OP to Z. The angles ZPR, ZPV, are given, $\left(\text{and RPV is nearly} = \frac{\text{ZPR}}{27}\right)$ and the intersections G and g with the axis. Let F be the focus of parallel red light coming through the lens RD in the opposite direction. Then (by the common optical theorem), the perpendicular F ϱ will cut PR in such a point ϱ, that ϱ F will be parallel to the emergent ray R r, and to V v. Therefore if ϱ D cut PV in u, and $u\,f$ be drawn perpendicular to the axis, we shall have (also by the common theorem) the point f for the focus of violet rays, and DF : D f = D ϱ : D u = 28 : 27 nearly, or in a given ratio.

The problem is therefore reduced to this, "To draw from a point D in the line CG a line D ϱ, which shall be cut by the lines PR and PV in the given ratio."

The following construction naturally offers itself: Make GM : g M in the given ratio, and draw MK parallel to P g. Through *any* point D of CG draw the straight line PDK, cutting MK in K. Join GK, and draw D ϱ parallel to KG. This will solve the problem; and, drawing ϱ F perpendicular to the axis, we shall have F for the focus of the lens RD for parallel red rays.

The demonstration is evident: for MK being parallel to P g, we have GM : gM = GK : HK, = ϱ D : u D = FD f D, in the ratio required.

This problem admits of an infinity of solutions; because the point D may be taken anywhere in the line CG. It may therefore be subjected to such conditions as may produce other advantages.

1. It may be restricted by the magnifying power, or by the division which we choose to make of the whole refraction which produces this magnifying power. Thus, if we have resolved to diminish the aberrations by making the two refractions equal, we have determined the angle R r D. Therefore draw GK, making the angle MGK equal to that which the emergent pencil must make with the axis, in order to produce this magnifying power. Then draw MK parallel to P g, meeting GK in K. Then draw PK, cutting the axis in D, and D ϱ parallel to GK, and ϱ F perpendicular to the axis. D is the place, and DF the focal distance of the eye-glass.

2. Particular circumstances may cause us to fix on a particular place D, and we only want the focal distance. In this case the first construction suffices.

3. We may have determined on a certain focal distance DF, and the place must be determined. In this case let

$$\text{GF} : \text{F}\varrho = 1 : \tan. \text{G}$$
$$\text{F}\varrho : f u = 1 : m,\ m \text{ being} = \tfrac{27}{28}$$
$$f u : f g = \tan. g : 1$$
$$\text{then}\quad \text{GF} : f g = \tan. g : m \tan. \text{G}$$
$$\text{then}\quad \text{GF} - f g : \text{GF} = \tan. g - m \tan. \text{G} : \tan. g$$
$$\text{or}\quad \text{G}g + \text{F}f : \text{GF} = \tan. g - m \tan. \text{G} : \tan. g;$$
$$\text{and}\quad \text{GF} = \text{G}g + \text{F}f \frac{\tan. g}{\tan. g - m \tan. \text{G}},$$

and is therefore given, and the place of F is determined; and since FD is given by supposition, D is determined.

The application of this problem to our purpose is difficult, if we take it in the most general terms; but the nature of the thing makes such limitations that it becomes very easy. In the case of the dispersion of light, the angle GPg is so small that MK may be drawn parallel to PG without any sensible error. If the ray OP were parallel to CG, then G would be the focus of the lens PC, and the point M would fall on C; because the focal distance of red rays is to that of violet rays in the same proportion for every lens, and therefore CG : Cg = DF : Df. Now, in a telescope which magnifies considerably, the angle at the object-glass is very small, and CG hardly exceeds the focal distance; and CG is to C g very nearly in the same proportion of 28 to 27. We may therefore draw through C (fig. 22.) a line CK Fig. 22. parallel

parallel to PG; then draw GK′ perpendicular to the axis of the lenses, and join PK′; draw K′BE parallel to CG, cutting PK in B; draw BHI parallel to GK, cutting GK′ in H: Join HD and PK. It is evident that CG is bisected in F′, and that K′B=2 F′D: also K′H : HG=K′B : BE, =CD : DG. Therefore DH is parallel to CK′, or to PG. But because PF′=F′K′, PD is = DB, and IH=HB. Therefore ϱ D=HB, and FD=K′B, = 2 F′D; and FD is bisected in F′. Therefore $CD=\frac{CG+FD}{2}$.

That is, in order that the eye-glass RD may correct the dispersion of the field-glass PC, *the distance between them must be equal to the half sum of their focal distances* very nearly. More exactly, *the distance between them must be equal to the half sum of the focal distance of the eye-glass, and the distance at which the field-glass would form an image of the object-glass.* For the point G is the focus to which a ray coming from the centre of the object-glass is refracted by the field-glass.

This is a very simple solution of this important problem. Huyghens's eye-piece corresponds with it exactly. If indeed the dispersion at P is not entirely produced by the refraction, but perhaps combined with some previous dispersion, the point M (fig. 21.) will not coincide with C (fig. 22.), and we shall have GC to GM, as the natural dispersion at P to the dispersion which really obtains there. This may destroy the equation $CD=\frac{CG+FD}{2}$.

Fig. 21. Fig. 22.

Thus, in a manner rather unexpected, have we freed the eye-glasses from the greatest part of the effect of dispersion. We may do it entirely by pushing the eye-glass a little nearer to the field-glass. This will render the violet rays a little divergent from the red, so as to produce a perfect picture at the bottom of the eye. But by doing so we have hurt the distinctness of the whole picture, because F is not in the focus of RD. We remedy this by drawing both glasses out a little, and the telescope is made perfect.

Fig. 20. This improvement cannot be applied to the construction of quadrant telescopes, such as fig. 20. Mr Ramsden has attempted it, however, in a very ingenious way, which merits a place here, and is also instructive in another way. The field-glass HD is a plano-convex, with its plane side next the image GF. It is placed very near this image. The consequence of this disposition is, that the image GF produces a vertical image *g f*, which is much less convex towards the glass. He then places a lens on the point C, where the red ray would cross the axis. The violet ray will pass on the other side of it. If the focal distance of this glass be *f c*, the vision will be distinct and free from colour. It has, however, the inconveniency of obliging the eye to be close to the glass, which is very troublesome.

This would be a good construction for a magic-lanthorn, or for the object-glass of a solar microscope, or indeed of any compound microscope.

We may presume that the reader is now pretty familiar with the different circumstances which must be considered in the construction of an eye-piece, and proceed to consider those which must be employed to erect the object.

This may be done by placing the lens which receives the light from the object-glass in such a manner, that a second image (inverted with respect to the first) may be formed beyond it, and this may be viewed by an eye-glass. Such a construction is represented in fig. 23. But, besides many other defects, it tinges the object prodigiously with colour. The ray *o d* is dispersed at *d* into the red ray *d r*, and the violet *d v*, *v* being farther from the centre than *r*, the refracted ray *v v′* crosses *r r′* both by reason of spherical aberration and its greater refrangibility.

Plate DXXX. fig. 23.

But the common day telescope, invented by F. Rheita, has, in this respect, greatly the advantage of the one now described. The rays of compound light are dispersed at two points. The violet ray in its course falls without the red ray, but is accurately collected with it at a common focus, as we shall demonstrate by and by. Since they cross each other in the focus, the violet ray must fall within the red ray, and be less refracted than if it had fallen on the same point with the red ray. Had it fallen there it would have separated from it; but by a proper diminution of its refraction, it is kept parallel to it, or nearly so. And this is one excellence of this telescope: when constructed with three eye-glasses perfectly equal, the colour is sensibly diminished, and by using an eye-glass somewhat smaller, it may be removed entirely.—We say no more of it at present, because we shall find its construction included in another, which is still more perfect.

It is evident at first sight that this telescope may be improved, by substituting for the eye-glass the Huyghenian double eye-glass, or field-glass and eye-glass represented in fig. 19. and 20.; and that the first of these may be improved and rendered achromatic. This will require the two glasses *e f* and *g h* to be increased from their present dimensions to the size of a field-glass, suited to the magnifying power of the telescope, supposing it an astronomical telescope. Thus we shall have a telescope of four eye-glasses. The three first will be of a considerable focal distance, and two of them will have a common focus at *b*. But this is considerably different from the eye-piece of four glasses which are now used, and are far better. We are indebted for them to Mr Dollond, who was a mathematician as well as an artist, and in the course of his research discovered resources which had not been thought of. He had not then discovered the achromatic object-glass, and was busy in improving the eye-glasses by diminishing their spherical aberration. His first thought was to make the Huyghenian addition at both the images of the day telescope. This suggested to him the following eye-piece of five glasses.

Fig. 24. represents this eye-piece, but there is not room for the object glass at its proper distance. A pencil of rays coming from the upper point of the object is made to converge (by the object-glass) to G, where it would form a picture of that part of the object. But it is intercepted by the lens A *a*, and its axis is bent towards the axis of the telescope in the direction *a b*. At the same time, the rays which converged to G converge to *g*, and there is formed an inverted picture of the object at *g f*. The axis of the pencil is again refracted at *b*, Fig. 24.

 b, crosses the axis of the telescope in H, is refracted again at c, at d, and at e, and at last crosses the axis in I. The rays of this pencil, diverging from g, are made less diverging, and proceed as if they came from g', in the line B $g\,g'$. The lens c C causes them to converge to g', in the line G$''$ C g'. The lens d D makes them converge still more to G$''$, and there they form an erect picture G$''$ F$''$; diverging from G$''$, they are rendered parallel by the refraction at e.

At H the rays are nearly parallel. Had the glass B b been a little farther from A, they would have been accurately so, and the object-glass, with the glasses A and B, would have formed an astronomical telescope with the Huyghenian eye-piece. The glasses C, D, and E, are intended merely for bending the rays back again till they again cross the axis in I. The glass C tends chiefly to diminish the great angle BH b; and then the two glasses D and E are another Huyghenian eye-piece.

The art in this construction lies in the proper adjustment of the glasses, so as to divide the whole bending of the pencil pretty equally among them, and to form the last image in the focus of the eye-glass, and at a proper distance from the other glass. Bringing B nearer to A would bend the pencil more to the axis. Placing C farther from B would do the same thing; but this would be accompanied with more aberration, because the rays would fall at a greater distance from the centres of the lenses. The greatest bending is made at the field-glass D; and we imagine that the telescope would be improved, and made more distinct at the edges of the field, by employing another glass of great focal distance between C and D.

There is an image formed at H of the object-glasses, and the whole light passes through a small circle in this place. It is usual to put a plate here pierced with a hole which has the diameter of this image. A second image of the object-glass is formed at I, and indeed wherever the pencils cross the axis. A lens placed at H makes no change in any of the angles, nor in the magnifying power, and affects only the place where the images are formed. And, on the other hand, a lens placed at f, or F$''$, where a real image is formed, makes no change in the places of the images, but affects the mutual inclination of the pencils. This affords a resource to the artist, by which he may combine properties which seem incompatible.

The aperture of A determines the visible field and all the other apertures.

We must avoid forming a real image, such as $f\,g$, or F$''$ G$''$, on or very near any glass. For we cannot see this image without seeing along with it every particle of dust and every scratch on the glass. We see them as making part of the object when the image is exactly on the glass, and we see them confusedly, and so as to confuse the object, when the image is near it. For when the image is on or very near any glass, the pencil of light occupies a very small part of its surface, and a particle of dust intercepts a great proportion of it.

It is plain that this construction will not do for the telescope of graduated instruments, because the micrometer cannot be applied to the second image $f\,g$, on account of its being a little distorted, as has been observed of the Huyghenian eye-piece.

Also the interposition of the glass C makes it difficult to correct the dispersion.

By proper reasoning from the correction in the Huyghenian eye-piece, we are led to the best construction of one with three glasses; which we shall now consider, taking it in a particular form, which shall make the discussion easy, and make us fully masters of the principles which lead to a better form. Therefore let PA (fig. 25.) be the glass which first receives the light proceeding from the image formed by the object-glass, and let OP be the axis of the extreme pencil. This is refracted into PR, which is again refracted into R r by the next lens B r. Let b be the focus of parallel rays of the second lens. Draw P B r. We know that A b : b B=PB : B r, and that rays of one kind diverging from P will be collected at r. But if PR, PV be a red and a violet ray, the violet ray will be more refracted at V, and will cross the red ray in some intermediate point g of the line R r. If therefore the first image had been formed precisely on the lens PA, we should have a second image at $f\,g$ free from all coloured fringes. Fig. 25.

If the refractions at P and R are equal (as in the common day telescope), the dispersion at V must be equal to that at P, or the angle v V r=VPR. But we have ultimately RPV : R r V=BC : AB, (=B b : A b by the focal theorem). Therefore g V r : $g\,r$ V, (or $g\,r$: g V, or C f : f B)=B b : A b, and AB : A b= R r : R g.

This shows by the way the advantage of the common day telescope. In this AB=2 A b, and therefore f is the place of the last image which is free from coloured fringes. But this image will not be seen free from coloured fringes through the eye-glass C r, if f be its focus: For had $g\,r$, $g\,v$ been both red rays, they would have been parallel after refraction; but $g\,v$ being a violet ray, will be more refracted. It will not indeed be so much deflected from parallelism as the violet ray, which naturally accompanies the red ray to r, because it falls nearer the centre. By computation its dispersion is diminished about $\frac{1}{7}$th.

In order that $g\,v$ may be made parallel to $g\,r$ after refraction, the refraction at r must be such that the dispersion corresponding to it may be of a proper magnitude. How to determine this is the question. Let the dispersion at g be to the dispersion produced by the refraction at r (which is required for producing the intended magnifying power) as 1 to 9. Make 9 : 1= $f\,f'$: f' C, = f C : CD, and draw the perpendicular D r' meeting the refracted ray $r\,r'$ in r'. Then we know by the common focal theorem, that if f' be the focus of the lens C r, red rays diverging from g will be united in r'. But the violet ray $g\,v$ will be refracted into $v\,v'$ parallel to $r\,r'$. For the angle $v\,r'\,r$: $v\,g\,r$= (ultimately) f C : CD, =9 : 1. Therefore the angle $v\,r'\,r$ is equal to the dispersion produced at r, and therefore equal to $r'\,v\,v'$, and $v\,v'$ is parallel to $r\,r'$.

But by this we have destroyed the distinct vision of the image formed at $f\,g$, because it is no longer at the focus of the eye-glass. But distinct vision will be restored by pushing the glasses nearer to the object-glass. This makes the rays of each particular pencil more divergent after refraction through A, but scarcely makes any change in the directions of the pencils themselves. Thus the image comes to the focus f', and makes no sensible change in the dispersions.

In

Telescope.

In the common day telescope, the first image is formed in the anterior focus of the first eye-glass, and the second image is at the anterior focus of the last eye-glass. If we change this last for one of half the focal distance, and push in the eye-piece till the image formed by the object-glass is half way between the first eye-glass and its focus, the last image will be formed at the focus of the new eye-glass, and the eye-piece will be achromatic. This is easily seen by making the usual computations by the focal theorem. But the visible field is diminished, because we cannot give the same aperture as before to the new eye-glass; but we can substitute for it two eye-glasses like the former, placed close together. This will have the same focal distance with the new one, and will allow the same aperture that we had before.

On these principles may be demonstrated the correction of colour in eye-pieces with three glasses of the following construction.

Let the glasses A and B be placed so that the posterior focus of the first nearly coincides with the anterior focus of the second, or rather so that the anterior focus of B may be at the place where the image of the object-glass is formed, by which situation the aperture necessary for transmitting the whole light will be the smallest possible. Place the third C at a distance from the second, which exceeds the sum of their focal distances by a space which is a third proportional to the distance of the first and second, and the focal distance of the second. The distance of the first eye-glass from the object-glass must be equal to the product of the focal distance of the first and second divided by their sum.

Let O o, A a, B b, C c, the focal distances of the glasses, be O, a, b, c. Then make $AB = a+b$ nearly; $BC = b + c + \frac{b^2}{b+c}$; $OA = \frac{bc}{b+c}$. The amplification or magnifying power will be $= \frac{ob}{ac}$; the equivalent eye-glass $= \frac{ac}{b}$; and the field of vision $= 3438' \times \frac{\text{Aperture of A}}{\text{foc. dist. ob. gl.}}$.

These eye-pieces will admit the use of a micrometer at the place of the first image, because it has no distortion.

Mr Dollond was anxious to combine this achromatism of the eye-pieces with the advantages which he had found in the eye-pieces with five glasses. This eye-piece of three glasses necessarily has a very great refraction at the glass B, where the pencil which has come from the other side of the axis must be rendered again convergent, or at least parallel to it. This occasions considerable aberrations. This may be avoided by giving part of this refraction to a glass put between the first and second, in the same way as he has done by the glass B put between A and C in his five glass eye-piece. But this deranges the whole process. His ingenuity, however, surmounted this difficulty, and he made eye-pieces of four glasses, which seem as perfect as can be desired. He has not published his ingenious investigation; and we observe the London artists work very much at random, probably copying the proportions of some of his best glasses, without understanding the principle, and therefore frequently mistaking. We see many eye-pieces which are far from being achromatic. We imagine therefore that it will be an acceptable thing to the artists to have precise instructions how to proceed, nothing of this kind having appeared in our language, and the investigations of Euler, d'Alembert, and even Boscovich, being so abstruse as to be inaccessible to all but experienced analysts. We hope to render it extremely simple.

It is evident, that if we make the rays of different colours unite on the surface of the last eye-glass but one, commonly called the *field-glass*, the thing will be done, because the dispersion from this point of union will then unite with the dispersion produced by this glass alone; and this increased dispersion may be corrected by the last eye-glass in the way already shown.

Therefore let A, B (fig. 26.) be the stations which we have fixed on for the first and second eye-glasses, in order to give a proper portion of the whole refraction to the second glass. Let b be the anterior focus of B. Draw PB r through the centre of B. Make A b : b B $=$ AB : BK. Draw the perpendicular K r, meeting the refracted ray in r. We know by the focal theorem, that red rays diverging from P will converge to r; but the violet ray PV, being more refracted, will cross Rr in some point g. Drawing the perpendicular fg, we get f for the proper place of the field-glass. Let the refracted ray Rr, produced backward, meet the ray OP coming from the centre of the object-glass in O. Let the angle of dispersion RPV be called p, and the angle of dispersion at V, that is, r V v, be v, and the angle V r R be r. Fig. 26.

It is evident that $OR : OP = p : v$, because the dispersions are proportional to the sines of the refractions, which, in this case, are very nearly as the refractions themselves.

Let $\frac{OP}{OR}\left(\text{or } \frac{op}{pB} \text{ or } \frac{pB}{bB}\right)$ be made $= m$. Then $v = mp$; also $p : r = BK : AB, = bB : Ab$, and $r = p.\frac{Ab}{bB}$, or making $\frac{Ab}{Bb} = n$, $r = np$; therefore $v : r = m : n, = \frac{pB}{bB} : \frac{Ab}{bB}, = pB : Ab$.

The angle $RgV = gVr + grV = p.\overline{m+n}$; and $RgV : Rrv = Rr : Rg$, or $m+n : n = Rr : Rg$, and $Rg = Rr\frac{n}{m+n}$. But Rr is ultimately $= BK = AB\frac{bB}{Ab} = \frac{AB}{n}$. Therefore $Rg = \frac{AB}{n} \times \frac{n}{m+n} = \frac{n}{m+n}$, and $Bf = \frac{AB}{m+n}$.

This value of Bf is evidently $= bB \times \frac{AB}{pB + Ab}$. Now b B being a constant quantity while the glass B is the same, the place of union varies with $\frac{AB}{pB+Ab}$. If we remove B a little farther from A, we increase AB, and p B, and A b, each by the same quantity. This evidently diminishes Bf. On the other hand, bringing B nearer to A increases Bf. If we keep the distance between the glasses the same, but increase the focal distance b B, we augment Bf, because this change aug-

 ments

Telescope. ments the numerator and diminishes the denominator of the fraction $\frac{b\,B\times AB}{p\,B+A\,b}$.

In this manner we can unite the colours at what distance we please, and consequently can unite them in the place of the intended field-glass, from which they will diverge with an increased dispersion, viz. with the dispersion competent to the refraction produced there, and the dispersion $p\times\overline{m+n}$ conjoined.

It only remains to determine the proper focal distances of the field-glass and eye-glass, and the place of the eye-glass, so that this dispersion may be finally corrected.

This is an indeterminate problem, admitting of an infinity of solutions. We shall limit it by an equal division of the two remaining refractions, which are necessary in order to produce the intended magnifying power. This construction has the advantage of diminishing the aberration. Thus we know the two refractions, and the dispersion competent to each; it being nearly $\frac{1}{27}$th of the refraction. Call this q. The whole dispersion at the field-glass consists of q, and of the angle $\overline{K\,g\,V}$ of fig. 19. which we also know to be $=p\times\overline{m+n}$. Call their sum s.

Fig. 27. Let fig. 27. represent this addition to the eye-piece. $C\,g$ is the field-glass coming in the place of $f\,g$ of fig. 26. and $R\,g\,w$ is the red ray coming from the glass BR. Draw $g\,s$ parallel to the intended emergent pencil from the eye-glass; that is, making the angle $C\,s\,g$ with the axis correspond to the intended magnifying power. Bisect this angle by the line g K. Make $s\,g : g\,q = s : q$, and draw q K, cutting $C\,g$ in t. Draw $t\,\delta$ D, cutting $g\,k$ in δ, and the axis in D. Draw $\delta\,d$ and $D\,r$ perpendicular to the axis. Then a lens placed in D, having the focal distance $D\,d$, will destroy the dispersion at the lens $g\,c$, which refracts the ray $g\,w$ into $g\,r$.

Let $g\,v$ be the violet ray, making the angle $v\,g\,r = s$. It is plain, by the common optical theorem, that $g\,r$ will be refracted into $r\,r'$ parallel to δ D. Draw g D v' meeting $r\,r'$, and join $v\,r'$. By the focal theorem two red rays $g\,r\,g\,v$, will be united in r'. But the violet ray $g\,v$ will be more refracted, and will take the path $v\,v'$, making the angle of dispersion $r'\,v\,v = q$, very nearly, because the dispersion at v does not sensibly differ from that at r. Now, in the small angles of refraction which obtain in optical instruments, the angles $r\,r'\,v$, $r\,g\,v$ are very nearly as $g\,r$ and $r\,r'$, or as g D and D r', or as CD and DT; which, by the focal theorem, are as C d and dD: that is, $D\,d : d\,c = r\,g\,v : r\,r'v$. But $D\,d : d\,C = D\,\delta : \delta\,t, = s\,g : g\,q, = s : q$. But $r\,g\,v = s$; therefore $r\,r'\,v = q, = r'\,v\,v'$, and $v\,v'$ is parallel to $r\,r'$, and the whole dispersion at g is corrected by the lens D r. The focal distance C c of C g is had by drawing C x parallel to K g, meeting R g in x, and drawing $x\,c$ perpendicular to the axis.

It is easy to see that this (not inelegant) construction is not limited to the equality of the refractions $w\,g\,r$, K $r\,r'$. In whatever proportion the whole refraction $w\,g\,s$ is divided, we always can tell the proportion of the dispersions which the two refractions occasion at g and r, and can therefore find the values of s and q. Indeed this solution includes the problem in p. 266. col. 2. par. ult.; but it had not occurred to us till the present occasion. Our readers will not be displeased with this variety of resource. Telescope.

The intelligent reader will see, that in this solution some quantities and ratios are assumed as equal which are not strictly so, in the same manner as in all the elementary optical theorems. The parallelism, however, of $v\,v'$ and $r\,r'$ may be made accurate, by pushing the lens D r nearer to C g, or retiring it from it. We may also, by pushing it still nearer, induce a small divergency of the violet ray, so as to produce accurate vision in the eye, and may thus make the vision through a telescope more perfect than with the naked eye, where dispersion is by no means avoided. It would therefore be an improvement to have the eye-glass in a sliding tube for adjustment. Bring the telescope to distinct vision; and if any colour be visible about the edges of the field, shift the eye-glass till this colour is removed. The vision may now become indistinct: but this is corrected by shifting the place of the whole eye-piece.

We have examined trigonometrically the progress of a red and a violet ray through many eye-pieces of Dollond's and Ramsden's best telescopes; and we have found in all of them that the colours are united on or very near the field-glass; so that we presume that a theory somewhat analogous to ours has directed the ingenious inventors. We meet with many made by other artists, and even some of theirs, where a considerable degree of colour remains, sometimes in the natural order and often in the contrary order. This must happen in the hands of mere imitators, ignorant of principle. We presume that we have now made this principle sufficiently plain.

Fig. 28. represents the eye-piece of a very fine spy-glass by Mr Ramsden; the focal length of its object-glass is $8\frac{1}{2}$ inches, with $1\frac{1}{10}$th of aperture, 2° 05′ of visible field, and 15.4 magnifying power. The distances and focal lengths are of their proper dimensions, but the apertures are $\frac{1}{5}$ larger, that the progress of a lateral pencil might be more distinctly drawn. The dimensions are as follow: Fig. 28.

Foc. lengths $Aa = 0.775$ $Bb = 1.025$ $Cc = 1.01$ $Dd = 0.79$.
Distances $AB = 1.18$ $BC = 1.83$ $CD = 1.105$.

It is perfectly achromatic, and the colours are united, not precisely at the lens C g, but about $\frac{1}{20}$th of an inch nearer the eye-glass.

It is obvious that this combination of glasses may be used as a microscope; for if, instead of the image formed by the object-glass at FG, we substitute a small object, illuminated from behind, as in compound microscopes; and if we draw the eye-piece a very small way from this object, the pencils of parallel rays emergent from the eye-glass D will become convergent to very distant points, and will there form an inverted and enlarged picture of the object, which may be viewed by a Huyghenian eye-piece; and we may thus get high magnifying powers without using very deep glasses. We tried the eye-piece of which we have given the dimensions in this way, and found that it might be made to magnify 180 times with very great distinctness. When used as the magnifier of a solar microscope, it infinitely surpasses every thing we have ever seen. The picture formed by a solar microscope is generally so indistinct, that it is fit only for amusing ladies; but with this magnifier it seemed

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The only thing which remains to be considered in the theory of refracting telescopes is the forms of the different lenses. Hitherto we have had no occasion to consider any thing but their focal distances; but their aberrations depend greatly on the adjustment of their forms to their situations. When the conjugate focuses of a lens are determined by the services which it is to perform, there is a certain form or proportion between the curvatures of their anterior and posterior surfaces, which will make their aberrations the smallest possible.

It is evident that this proportion is to be obtained by making the fluxion of the quantity within the parenthesis in the formula at the top of col. 2. p. 248. equal to nothing. When this is done, we obtain this formula for a, the radius of curvature for the anterior surface of a lens. $\frac{1}{a}=\frac{2m^2+m}{2m+4}+\frac{4m+4}{2(m+4)r}$, where m is the ratio of the sine of incidence to the sine of refraction, and r is the distance of the focus of incident rays, positive or negative, according as they converge or diverge, all measured on a scale of which the unit is n, $=$ half of the radius of the equivalent isosceles lens.

It will be sufficiently exact for our purpose to suppose $m=\frac{3}{2}$, though it is more nearly $\frac{31}{20}$. In this case $\frac{1}{a}=\frac{6}{7}+\frac{10}{7r}$, $=\frac{42r+70}{49r}$. Therefore $a=\frac{49r}{42r+70}$. And $\frac{1}{b}=\frac{1}{a}-1$, $=\frac{1-a}{a}$.

As an example, let it be required to give the radii of curvature in inches for the eye-glass be of page 262. col. 1. par. 4. which we shall suppose of $1\frac{1}{2}$ inches focal distance, and that ec $(=r)$ is $3\frac{3}{4}$th inches.

The radius of curvature for the equivalent isosceles lens is 1.5, and its half is 0.75. Therefore $r=\frac{3\frac{3}{4}}{0.75}$, $=5$; and our formula is $a=\frac{49\times 5}{42\times 5+70}$, $=\frac{245}{280}$, $=0.875$; and $\frac{1}{b}=\frac{1-a}{a}$, $=\frac{0.125}{0.875}$, and $b=\frac{0.875}{0.125}$, $=7$.

These values are parts of a scale, of which the unit is 0.75 inches. Therefore

$$a\text{, in inches, }=0.875\times 0.75,=0.65525$$
$$b\text{, in inches, }=7\times 0.75,=5.25.$$

And here we must observe that the posterior surface is concave: for b is a positive quantity, because $1-a$ is a positive quantity as well as a; therefore the centre of sphericity of both surfaces lies beyond the lens.

And this determination is not very different from the usual practice, which commonly makes this lens a plane convex with its flat side next the eye: and there will not be much difference in the performance of these two lenses; for in all cases of maxima and minima, even a pretty considerable change of the best dimensions does not make a sensible change in the result.

The same consideration leads to a rule which is very simple, and sufficiently exact for ordinary situations. Telescope. This is to make the curvatures such, that the incident and emergent pencils may be nearly equally inclined to the surfaces of the lens. Thus in the eye-piece with five glasses, A and B should be most convex on their anterior sides; C should be most convex on the posterior side; D should be nearly isosceles; and E nearly plano-convex.

But this is not so easy a matter as appears at first sight. The lenses of an eye-piece have not only to bend the several pencils of light to and from the axis of the telescope; they have also to form images on the axes of these pencils. These offices frequently require opposite forms, as mentioned in par. 3. col. 2. p. 261. Thus the glass A, fig. 28. should be most convex on the side next the object, that it may produce little distortion Fig. 28. of the pencils. But it should be most convex next the eye, that it may produce distinct vision of the image FG, which is very near it. This image should have its concavity turned towards A, whereas it is towards the object-glass. We must therefore endeavour to make the vertical image fg flatter, or even convex. This requires a glass very flat before and convex behind. For similar reasons the object-glass of a microscope and the simple eye-glass of an astronomical telescope should be formed the same way.

This is a subject of most difficult discussion, and requires a theory which few of our readers would relish; nor does our limits afford room for it. The artists are obliged to grope their way. The proper method of experiment would be, to make eye-pieces of large dimensions, with extravagant apertures to increase the aberrations, and to provide for each station A, B, C, and D, a number of lenses of the same focal distance, but of different forms; and we would advise making the trial in the way of a solar microscope, and to have two eye-pieces on trial at once. Their pictures can be formed on the same screen, and accurately compared; whereas it is difficult to keep in remembrance the performance of one eye-piece, and compare it with another.

We have now treated the theory of refracting telescopes with considerable minuteness, and have perhaps exceeded the limits which some readers may think reasonable. But we have long regretted that there is not any theory on this subject from which a curious person can learn the improvements which have been made since the time of Dr Smith, or an artist learn how to proceed with intelligence in his profession. If we have accomplished either of these ends, we trust that the public will receive our labours with satisfaction.

We cannot add any thing to what Dr Smith has delivered on the theory of reflecting telescopes. There appears to be the same possibility of correcting the aberration of the great speculum by the contrary aberration of a convex small speculum, that we have practised in the compound object-glass of an achromatic refracting telescope. But this cannot be, unless we make the radius of the convex speculum exceedingly large, which destroys the magnifying power and the brightness. This therefore must be given up. Indeed their performance, when well executed, does already surpass all imagination. Dr Herschel has found great advantages in what he calls the *front view*, not using a plane mirror to throw the pencils to one side. But this cannot be-

Telescope. be practised in any but telescopes so large, that the loss of light, occasioned by the interposition of the observer's head, may be disregarded.

Nothing remains but to describe the mechanism of some of the most convenient forms.

To describe all the varieties of shape and accommodation which may be given to a telescope, would be a task as trifling as prolix. The artists of London and of Paris have racked their inventions to please every fancy, and to suit every purpose. We shall content ourselves with a few general maxims, deduced from the scientific consideration of a telescope, as an instrument by which the visual angle subtended by a distant object is greatly magnified.

The chief consideration is to have a steady view of the distant object. This is unattainable, unless the axis of the instrument be kept constantly directed to the same point of it: for when the telescope is gently shifted from its position, the object *seems to move* in the same or in the opposite direction, according as the telescope inverts the object or shows it erect. This is owing to the magnifying power, because the apparent angular motion is greater than what we naturally connect with the motion of the telescope. This does not happen when we look through a tube without glasses.

All shaking of the instrument therefore makes the object dance before the eye; and this is disagreeable, and hinders us from seeing it distinctly. But a tremulous motion, however small, is infinitely more prejudicial to the performance of a telescope, by making the object quiver before us. A person walking in the room prevents us from seeing distinctly; nay, the very pulsation in the body of the observer, agitates the floor enough to produce this effect, when the telescope has a great magnifying power: For the visible motion of the object is then an imperceptible tremor, like that of an harpsichord wire, which produces an effect precisely similar to optical indistinctness; and every point of the object is diffused over the whole space of the angular tremor, and appears coexistent in every part of this space, just as a harpsichord wire does while it is sounding. The more rapid this motion is, the indistinctness is the more complete. Therefore the more firm and elastic and well bound together the frame-work and apertures of our telescope is, the more hurtful will this consequence be. A mounting of lead, were it practicable, would be preferable to wood, iron, or brass. This is one great cause of the indistinctness of the very finest reflecting telescopes of the usual constructions, and can never be totally removed. In the Gregorian form, it is hardly possible to damp the elastic tremor of the small speculum, carried by an arm supported at one end only, even though the tube were motionless. We were witnesses of a great improvement made on a four feet reflecting telescope, by supporting the small speculum by a strong plate of lead placed across the tube, and led by an adjusting screw at each end. But even the great mirror may vibrate enough to produce indistinctness. Refracting telescopes are free from this inconveniency, because a small angular motion of the object-glass round one of its own diameters has no sensible effect on the image in its focus. They are affected only by an angular motion of the axis of the telescope or of the eye-glasses.

This single consideration gives us great help towards judging of the merits of any particular apparatus. We should study it in this particular, and see whether its form makes the tube readily susceptible of such tremulous motions. If it does, the firmer it is and the more elastic it is, the worse. All forms therefore where the tube is supported only near the middle, or where the whole immediately or remotely depend on one narrow joint, are defective.

Reasoning in this way, we say with confidence, that of all the forms of a telescope apparatus, the old fashioned simple stand represented in fig. 29. is by far the best, and that others are superior according as the disposition of the points of support of the tube approaches to this. Let the pivots A, B, be fixed in the lintel and sole of a window. Let the four braces terminate very near to these pivots. Let the telescope lie on the pin F *f*, resting on the shoulder round the eye-piece, while the far end of it rests on one of the pins 1, 2, 3, &c.; and let the distance of these pins from F very little exceed the length of the telescope. The trembling of the axis, even when considerable, cannot affect the position of the tube, because the braces terminate almost at the pivots. The tremor of the brace CD does as little harm, because it is nearly perpendicular to the tube. And if the object-glass were close at the upper supporting pin, and the focus at the lower pin F, even the bending and trembling of the tube will have no effect on its optical axis. The instrument is only subject to horizontal tremors. These may be almost annihilated by having a slender rod coming from a hook's joint in the side of the window, and passing through such another joint close by the pin F. We have seen an instrument of this form, having AB parallel to the earth's axis. The whole apparatus did not cost 50 shillings, and we find it not in the least sensible manner affected by a storm of wind. It was by observations with this instrument that the tables of the motions of the Georgium Sidus, published in the Edinburgh Transactions, were constructed, and they are as accurate as any that have yet appeared. This is an excellent equatorial. Fig. 29.

But this apparatus is not portable, and it is sadly deficient in elegance. The following is the best method we have seen of combining these circumstances with the indispensable requisites of a good telescope.

The pillar VX (fig. 30.) rises from a firm stand, and has a horizontal motion round a cone which completely fills it. This motion is regulated by a rack-work in the box at V. The screw of this rack-work is turned by means of the handle P, of a convenient length, and the screw may be disengaged by the click or detent V, when we would turn the instrument a great way at once. The telescope has a vertical motion round the joint Q placed near the middle of the tube. The lower end of the tube is supported by the stay OT. This consists of a tube RT, fastened to the pillar by a joint T, which allows the stay to move in a vertical plane. Within this tube slides another, with a stiff motion. This tube is connected with the telescope by another joint O, also admitting motion in a vertical plane. The side M of this inner tube is formed into a rack, in which works a pinion fixed to the top of the tube RT, and turned by the flat finger-piece R. The reader will readily see the advantages and the remaining defects of this apparatus. It is very portable, because the telescope is easily disengaged from it, and the legs and stay fold up. If the joint Fig. 30.

joint Q were immediately under A, it would be much freer from all tremor in the vertical plane. But nothing can hinder other tremors arising from the long pillar and the three springy legs. These communicate all external agitations with great vigour. The instrument should be set on a stone pedestal, or, what is better, a cask filled with wet sand. This pedestal, which necessity perhaps suggested to our scientific navigators, is the best that can be imagined.

Fig. 31. Fig. 31. is the stand usually given to reflecting telescopes. The vertical tube FBG is fastened to the tube by finger screws, which pass through the slits at F and G. This arch turns round a joint in the head of the divided pillar, and has its edge cut into an oblique rack, which is acted on by the horizontal screw, furnished with the finger-piece A. This screw turns in a horizontal square frame. This frame turns round a horizontal joint in the off-side, which cannot be seen in this view. In the side of this frame next the eye there is a finger-screw *a*, which passes through the frame, and presses on the round horizontal plate D. By screwing down this finger-screw, the frame is brought up, and presses the horizontal screw to the rack. Thus the elevation of the telescope is fixed, and may be nicely changed by the finger applied to A, and turning this screw. The horizontal round plate D moves stiffly round on another plate of nearly equal diameter. This under plate has a deep conical hollow socket, which is nicely fitted by grinding to a solid cone formed on the top of the great upright pillar, and they may be firmly fixed in any position by the finger-screw E. To the under plate is fastened a box *c*, containing a horizontal screw C, which always works in a rack cut in the edge of the upper plate, and cannot be disengaged from it. When a great vertical or horizontal motion is wanted, the screws *a* and E are slacked, and by tightening them the telescope may be fixed in any position, and then any small movements may be given it by the finger plates A and C.

This stand is very subject to brisk tremor, either from external agitation of the pedestal, or from the immediate action of the wind; and we have seldom seen distinctly through telescopes mounted in this manner, till one end of the tube was pressed against something that was very steady and unelastic. It is quite astonishing what a change this produces. We took a very fine telescope made by James Short, and laid the tube on a great lump of soft clay, pressing it firmly down into it. Several persons, ignorant of our purpose, looked through it, and read a table of logarithms at the distance of 310 yards. We then put the telescope on its stand, and pointed it at the same object; none of the company could read at a greater distance than 235 yards, although they could perceive no tremor. They thought the vision as sharp as before; but the incontrovertible proof of the contrary was, that they could not read at such a distance.

If the round plates were of much greater dimensions; and if the lower one, instead of being fixed to the pillar, were supported on four stout pillars standing on another plate; and if the vertical arch had a horizontal axis turning on two upright frames firmly fixed to the upper plate—the instrument would be much freer from tremor. Such stands were made formerly; but being much more bulky and inconvenient for package, they have gone into disuse.

The high magnifying powers of Dr Herschel's telescopes made all the usual apparatus for their support extremely imperfect. But his judgment, and his ingenuity and fertility in resource, are as eminent as his philosophical ardour. He has contrived for his reflecting telescope stands which have every property that can be desired. The tubes are all supported at the two ends. The motions, both vertical and horizontal, are contrived with the utmost simplicity and firmness. We cannot more properly conclude this article than with a description of his 40 feet telescope, the noblest monument of philosophical and of princely munificence that the world can boast of.

Fig. 32. represents a view of this instrument in a meridional situation, as it appears when seen from a convenient distance by a person placed to the south-west of it. The foundation in the ground consists of two concentric circular brick walls, the outermost of which is 42 feet in diameter, and the inside one 21 feet. They are two feet six inches deep under ground; two feet three inches broad at the bottom, and one foot two inches at the top; and are capped with paving stones about three inches thick, and twelve and three quarters broad. The bottom frame of the whole apparatus rests upon these two walls by twenty concentric rollers III, and is moveable upon a pivot, which gives a horizontal motion to the whole apparatus, as well as to the telescope. Plate DXXXI. fig. 32.

The tube of the telescope, A, though very simple in its form, which is cylindrical, was attended with great difficulties in the construction. This is not to be wondered at; when its size, and the materials of which it is made, are considered. Its length is 39 feet four inches; it measures four feet ten inches in diameter; and every part of it is of iron. Upon a moderate computation, the weight of a wooden tube must have exceeded an iron one at least 3000 pounds; and its durability would have been far inferior to that of iron. It is made of rolled or sheet iron, which has been joined together without rivets, by a kind of seaming well known to those who make iron funnels for stoves.

Very great mechanical skill is used in the contrivance of the apparatus by which the telescope is supported and directed. In order to command every altitude, the point of support is moveable; and its motion is effected by mechanism, so that the telescope may be moved from its most backward point of support to the most forward, and, by means of the pulleys GG suspended from the great beam H, be set to any altitude, up to the very zenith. The tube is also made to rest with the point of support in a pivot, which permits it to be turned sidewise.

The concave face of the great mirror is 48 inches of polished surface in diameter. The thickness, which is equal in every part of it, remains now about three inches and a half; and its weight, when it came from the cast was 2118 pounds, of which it must have lost a small quantity in polishing. To put this speculum into the tube, it is suspended vertically by a crane in the laboratory, and placed on a small narrow carriage, which is drawn out, rolling upon planks, till it comes near the back of the tube; here it is again suspended

suspended and placed in the tube by a peculiar apparatus.

The method of observing by this telescope is by what Dr Herschel calls the *front view*; the observer being placed in a seat C, suspended at the end of it, with his back towards the object he views. There is no small speculum, but the magnifiers are applied immediately to the first focal image.

From the opening of the telescope, near the place of the eye-glass, a speaking pipe runs down to the bottom of the tube, where it goes into a turning point; and after several other inflections, it at length divides into two branches, one going into the observatory D, and the other into the work-room E. By means of the speaking pipe the communications of the observer are conveyed to the assistant in the observatory, and the workman is directed to perform the required motions.

In the observatory is placed a valuable sidereal time-piece, made by Mr Shelton. Close to it, and of the same height, is a polar distance-piece, which has a dial-plate of the same dimensions with the time-piece: this piece may be made to show polar distance, zenith distance, declination, or altitude, by setting it differently. The time and polar distance pieces are placed so that the assistants sit before them at a table, with the speaking pipe rising between them; and in this manner observations may be written down very conveniently.

This noble instrument, with proper eye-glasses, magnifies above 6000 times, and is the largest that has ever been made. Such of our readers as wish for a fuller account of the machinery attached to it, viz. the stairs, ladders, and platform B, may have recourse to the second part of the Transactions of the Royal Society for 1795; in which, by means of 18 plates and 63 pages of letter-press, an ample detail is given of every circumstance relating to joiner's work, carpenter's work, and smith's work, which attended the formation and erection of this telescope. It was completed on August the 28th 1789, and on the same day was the sixth satellite of Saturn discovered.

TELL, WILLIAM, an illustrious Swiss patriot, chief instrument of the revolution which delivered the Swiss cantons from the German yoke in 1307. Grisler, the governor of these provinces for the emperor Albert, having ordered him, under pain of death, to shoot at an apple placed on the head of one of his children; he had the dexterity, though the distance was very considerable, to strike it off without hitting the child. The tyrant, perceiving he had another arrow concealed under his cloak, asked him for what purpose? To which he boldly replied, "To have shot you through the heart, if I had had the misfortune to kill my son." The enraged governor now ordered him to be hanged; but his fellow-citizens, animated by his fortitude and patriotism, flew to arms; attacked and vanquished Grisler, who was shot to death by Tell; and the association for the independency took place that instant.

Tell-Tale, a name sometimes given to the *Perpetual-Log*. See that article.

TELLER, an officer of the exchequer, in ancient records called *tallier*. There are four of these officers, whose duty is to receive all sums due to the king, and to give the clerk of the pells a bill to charge him therewith. They likewise pay all money due from the king, by warrant from the auditor of the receipt; and make weekly and yearly books both of their receipts and payments, which they deliver to the lord treasurer.

TELLINA, a genus of shell-fish. See CONCHOLOGY *Index*.

TEMISSA, a large town in Africa, about 120 miles north-east of Mourzouk, the capital of Fezzan. Here the caravan of pilgrims from Bornou and Nigritia, which takes its departure from Mourzouk, and travels by the way of Cairo to Mecca, usually provides the stores of corn and dates, and dried meat, that are requisite for its dreary passage.

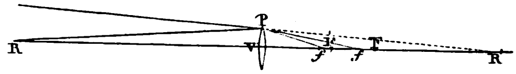
TEMPE, in *Ancient Geography*, a most pleasant place or valley of Thessaly. That it was there, appears from the epithets of *Thessalica* (Livy), *Thessala* (Ovid). The doubts respecting the situation of this celebrated valley have been completely removed by Dr Clarke, who found its name in a Roman inscription on the face of the rock. It is the narrow and steep defile through which the Peneus escapes from the Thessalian plain. This defile is formed by Mount Olympus on the north, and Mount Ossa on the south. It is richly wooded, while lofty precipices present their bare fronts of various colours, amidst the trees. The village of Ampelakia, celebrated for its manufacture of *Turkey red*, lies within this valley on the south side. The Peneus, according to Pliny, running down between Ossa to the south and Olympus to the north for 500 stadia, is for half that space navigable: in the direction of this course lies what is called *Tempe*, extending in length for five miles, in breadth for about an acre and a half, with gentle convexities rising on the right and left hand. Within glides the pure stream of the Peneus, charming in the grass on its banks, and harmoniously vocal with the music of birds. In this description Strabo and Ælian agree; the last adding, that it has an agreeable variety of places of retreat; and that it is not the work of man's hand, but the spontaneous production of nature; and Strabo says, that formerly the Peneus formed a lake in this spot, being checked in its course by the higher grounds about the sea; but that an opening being made by an earthquake, and Mount Ossa torn from Olympus, the Peneus gained a free course between them. But Livy, who calls Tempe a grove, remarks a degree of horror rather than amenity, with which the Roman army was struck on marching over the narrow pass; for, besides the defile, difficult to go over, which runs on for five miles, there are steep rocks on each hand, down which the prospect is apt to cause a dizziness, heightened by the noise and depth of the interfluent Peneus.

TEMPER, in a mechanical sense. See TEMPERING.

TEMPER, in a moral sense, the disposition of mind, whether natural or acquired. The word is seldom used by good writers without an epithet, as a *good* or *bad* temper, though one of the most beautiful poems in the language is entitled *The Triumphs of Temper*.

It is well observed by an elegant Essayist, that more constant uneasiness arises from ill temper than from ill fortune; as a bad temper embitters every sweet, and converts a paradise into a place of torment. For subduing the heart to softness, and preserving a due balance of the passions, a proper culture of the understanding and of the taste is the best method. He who employs his

Fig. 7.



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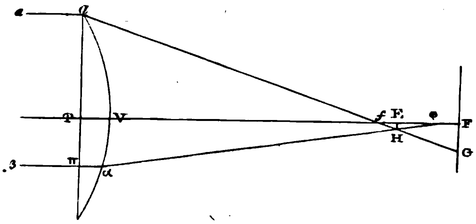

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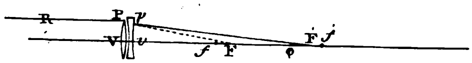

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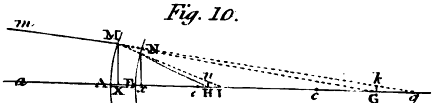

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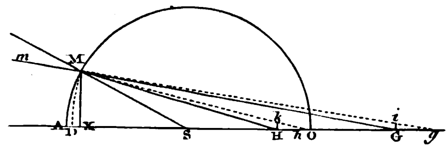

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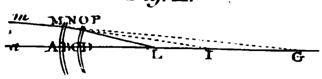

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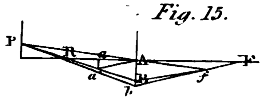

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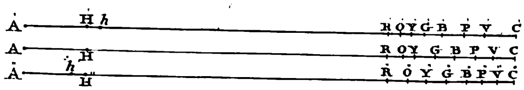

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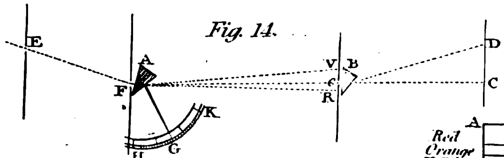

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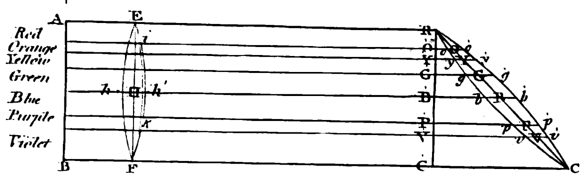

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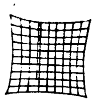

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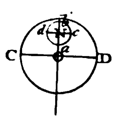

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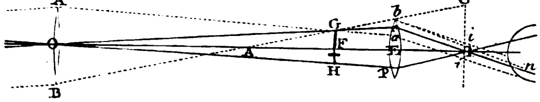

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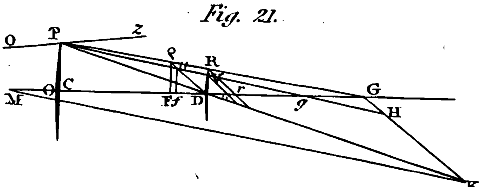

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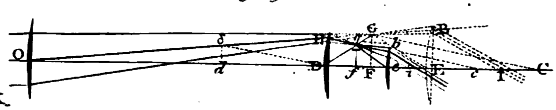

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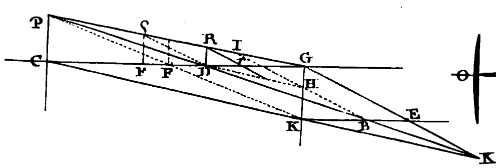

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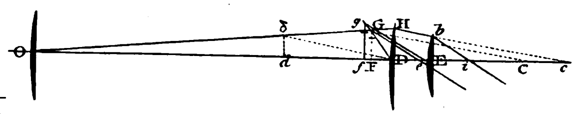
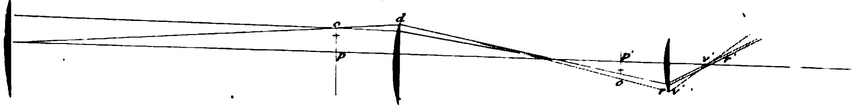


W. Tomlin Sculp.

Fig. 23.



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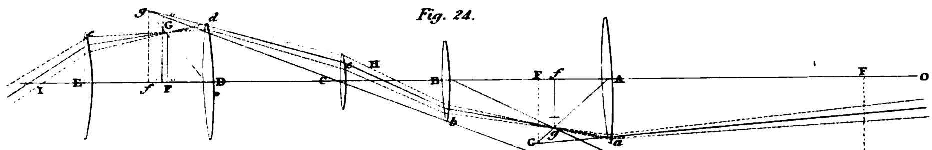

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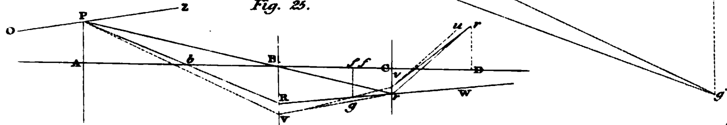

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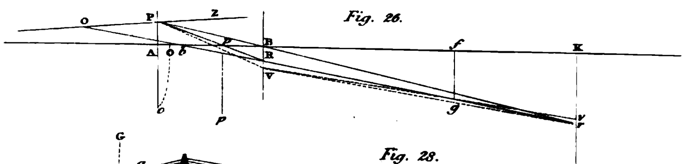

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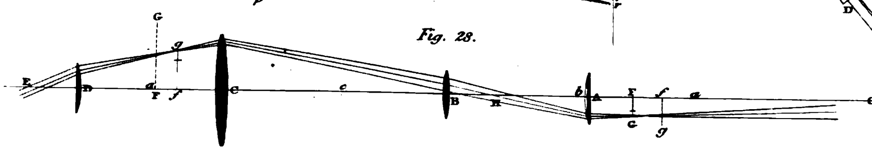

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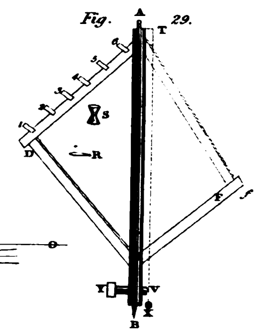

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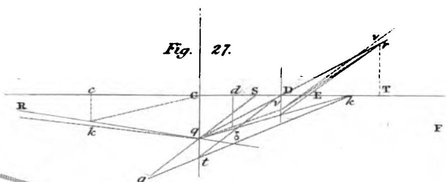

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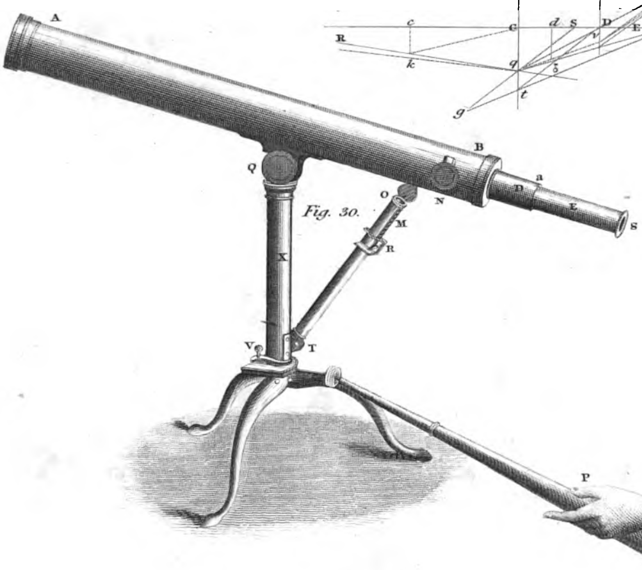

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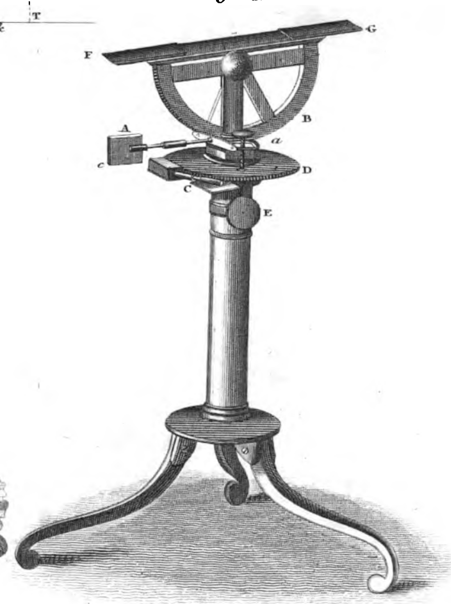
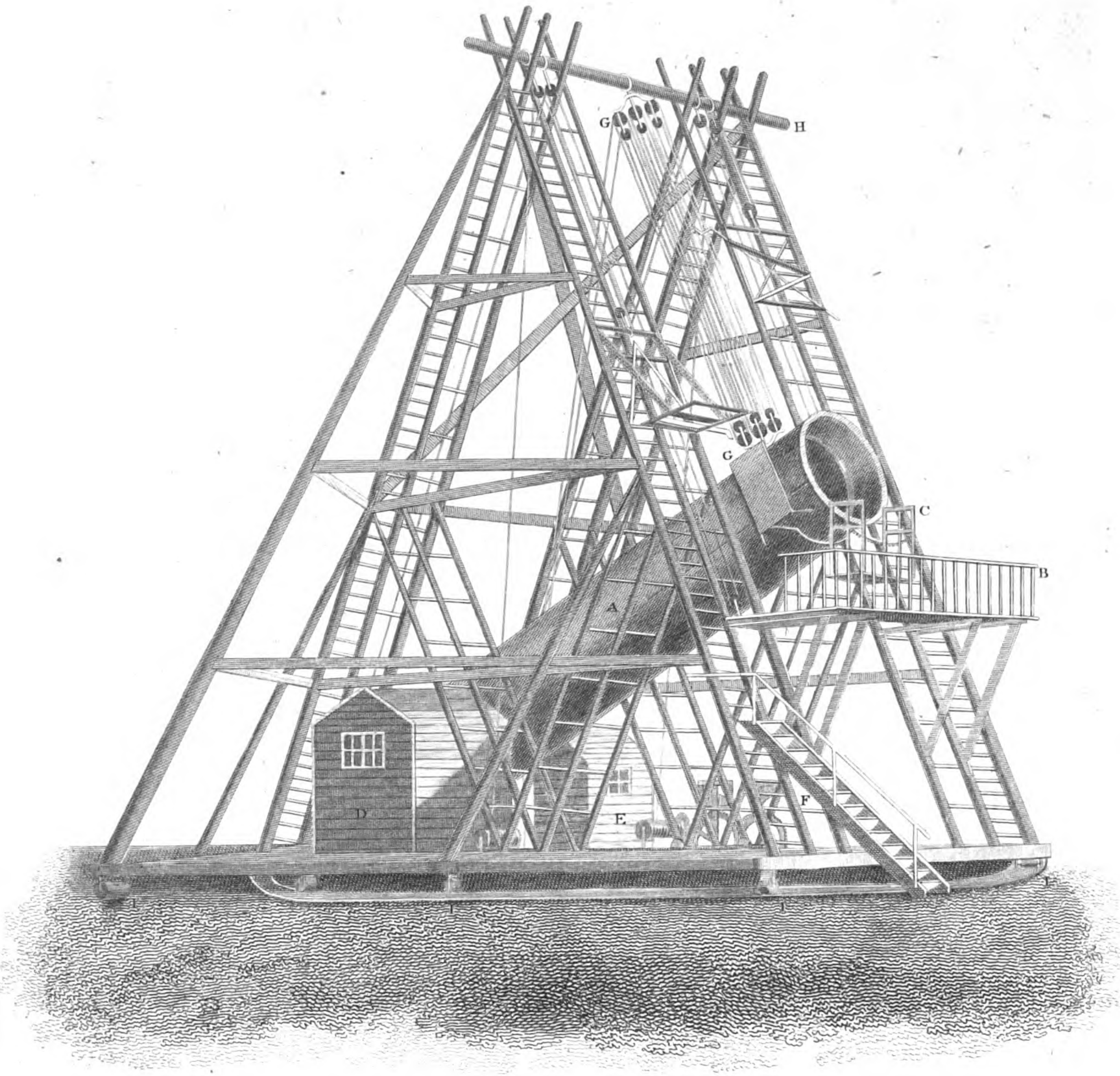


Fig. 32.



E. Mitchell sculp.

Temper, Temperament.

his time in the studies of elegant literature, or the fine arts, has almost always a good temper; whilst the man who is absorbed in the pursuits of profound science is apt to acquire a severity of disposition, little less disagreeable, though generally much less pernicious, than the capriciousness of the idler. Music, painting, and poetry, teach the mind to select the agreeable parts of those objects which surround us, and by habituating it to a pure and permanent delight, gradually superinduce an habitual good humour. It is of infinite importance to happiness to accustom the mind, from infancy, to turn from deformed and painful scenes, and to contemplate whatever can be found of moral and natural beauty.

So much of the happiness of private life depends on the government of the temper, that the temper ought to be a principal object of regard in a well-conducted education. The suffering of children to tyrannize without controul over servants and inferiors, is the ruin of many an amiable disposition. The virtues of humanity, benevolence, humility, cannot be too early enforced; at the same time, care should be taken that an infant of two or three years old should never be beaten or spoken to harshly for any offence which it can possibly commit.

TEMPERAMENT, among physicians, the same with constitution, or a certain disposition of the solids and fluids of the human body, by which it may be properly denominated strong, weak, lax, &c.

In every person there are appearances of a temperament peculiar to himself, though the ancients only took notice of four, and some have imagined these were deduced from the theories of the four humours or four cardinal qualities; but it is more probable that they were first founded on observation, and afterwards adapted to those theories, since we find that they have a real existence, and are capable of receiving an explanation. The two that are most distinctly marked are the sanguineous and melancholic, viz. the temperaments of youth and age.

1. *Sanguineous.* Here there is laxity of solids, discoverable by the softness of hair and succulency; large system of arteries, redundancy of fluids, florid complexion; sensibility of the nervous power, especially to pleasing objects; irritability from the plethora; mobility and levity from lax solids. These characters are distinctly marked, and are proved by the diseases incident to this age, as hæmorrhagies, fevers, &c. but these, as they proceed from a lax system, are more easily cured.

2. *Melancholic Habit.* Here greater rigidity of solids occurs, discoverable by the hardness and crispature of the hair; small proportion of the fluids, hence dryness and leanness; small arteries, hence pale colour; venous plethora, hence turgescency of these, and lividity; sensibility, frequently exquisite; moderate irritability, with remarkable tenacity of impressions; steadiness in action and slowness of motion, with great strength; for excess of this constitution in maniacs gives the most extraordinary instance of human strength we know. This temperament is most distinctly marked in old age, and in males. The sanguineous temperament of youth makes us not distinguish the melancholic till the decline of life, when it is very evident, from diseases of the veins, hæmorrhoids, apoplexy, cachexy, obstructions of the viscera, particularly of the liver, dropsies, affections of the alimentary canal, chiefly from weaker influence of the nervous power. So much for the sanguineous and melancholic temperaments; the other two are not so easily explained. The choleric temperament takes place between youth and manhood. In the

3. *Choleric,* the distribution of the fluids is more exactly balanced; there is less sensibility, and less obesity, with more irritability, proceeding from greater tension, less mobility and levity, and more steadiness in the strength of the nervous power. As to the

4. *Phlegmatic.* This temperament cannot be distinguished by any characters of age or sex. It agrees with the sanguineous in laxity and succulency. It differs from that temperament, and the melancholic, by the more exact distribution of the fluids. Again, it differs from the sanguineous, by having less sensibility, irritability, mobility, and perhaps strength, though sometimes indeed this last is found to be great.

These are the ancient temperaments. The temperaments, indeed, are much more various; and very far from being easily marked and reduced to their genera and species, from the great variety which is observable in the constitutions of different men.

Temperament of the Musical Scale, is that modification of the sounds of a musical instrument, by which those sounds may be made to serve for different degrees of different scales. See Music, Chap. VII. 1 Definition.

Temperament, though intimately connected with music, is not, properly speaking, a part of that science. The objects of music, as a science, are, to ascertain the laws of musical sound, as depending on the powers of the human voice. The purpose of temperament is, to regulate, in a way least adverse to these laws, a certain departure from them, rendered necessary by the imperfections of instruments.

Although the temperament of the scale of instruments be practically familiar, the true principles on which it depends have been much disputed. Various opinions have been hazarded, and systems proposed. We offer an abridged view of that which appears to us to merit a preference (A).

Before consideration of the tempered scale, a short review of the nature of the true scale is necessary. 2 Nature of the true scale.

From the conformation of the vocal organs, all nations, in singing, make use of the same inflections of voice. These inflections, called *notes,* are said to be *grave* or *acute,* in proportion to the degree of hoarseness or shrillness with which they are sung. The state of voice with respect to gravity or acuteness with which any one note is sung, is termed its *pitch.* 3 Notes, and their pitch.

Two notes having the same pitch are termed *unisons,* or are said to be *in unison* to one another. The difference of pitch between any note and another is denominated an *interval.* 4 Unisons and intervals.

In

(A) Amongst the very numerous authors on the subject of temperament, we have selected, for our chief guides, the late Dr Robert Smith of Cambridge, and Professor John Robison of Edinburgh.

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5 Key note or fundamental.

In all attempts to sing, the ear, either unconsciously, or from the direction of recently hearing it, selects a particular note, from the previous impression of which the voice naturally forms other notes, at certain though unequal intervals. The note, thus selected, is termed the *key note* or *fundamental*. When chosen, it instantly assumes a particular and predominant character. The ear involuntarily refers to it the intonation of all other notes, readily recurs to it during performance, and is dissatisfied unless the voice close upon it.

6 Natural scale and its degrees.

Where the singer has assumed a key note, and, after singing that note, sings the note nearest in acuteness to it without forcing the voice, and so on, the series of notes, thus naturally formed, constitutes what is called the *natural scale*. The notes of it are termed its *degrees*; thus the key note is the first degree of the scale; the natural note next in acuteness to it, is named the second degree, or *second of the scale*, and so on.

7 Difference of pitch of the male and female voice.

Two untaught men, attempting to sing the same scale together, always sing in unison. But a man and a woman, making the same attempt, sing naturally in such a difference of pitch, although they proceed by the same intervals, that the eighth note only of the male voice ascending, is in unison with the key note of the female voice. Were the male voice to ascend to a ninth note, it would be in unison with the second of the female voice; the tenth note of the former would be in unison with the third of the latter, and so on.

We have thus two scales in succession, perfectly similar in the relation of the degrees of each to their respective key notes; but differing in pitch by the interval between these key notes.

8 Octave, what?

This interval, comprehending seven smaller intervals and eight degrees, is, from this last circumstance, called an *octave*: and this term is also applied, somewhat inaccurately, to the series of the eight degrees. Thus we say, that the *octave* formed by the female voice is an *octave* acuter than that which is produced by the male voice; meaning, that the eight degrees sung by the woman are acuter by the interval of an octave, than those sung by the man.

9 All octaves are similar.

Not only are the natural octaves of the male and female voice exactly similar; but the same similarity is found in the extremes of the human voice, and, beyond them, as far as musical sounds can be produced. Many men can sing the second octave below, and most women the second octave above, a given key note common to both voices. Yet the gravest octave of such a male voice, and the acutest octave of such a female voice, are equally similar in their relations (although they differ in pitch by an interval of two octaves), as the two central octaves are.

10 All music contained in one octave of the natural scale.

All the different natural inflections of the human voice are thus contained in one octave, since all other octaves are only repetitions of the same inflections in a graver or acuter pitch.

11 Octave consists of eight degrees and seven intervals.

The octave, then, consists of eight degrees and seven intervals. Two of these intervals, those between the third and fourth, and the seventh and eighth degrees, are sensibly less different in pitch than the others. And although we have no direct measures of the pitch of sounds, we term these smaller intervals *semitonic*, and the others *tonic* intervals, presuming the latter to be equal to each other, and a semitonic interval to be equal to the half of a tonic one.

12 Representation of the scale by letters.

The degrees of the natural scale are, by British musicians, distinguished by the first seven letters of the alphabet. The letter C, for some reason less important than difficult to explain, has been appropriated to the note most easily assumed as a key note by both the male and female voice; the second of the scale is termed D, and the third E, and so on. As the human voice, and consequently most musical compositions, comprehend four octaves, we represent the ordinary octave of the male voice by Roman capitals, and that of the female voice by Roman minuscular letters. The gravest male octave is distinguished by Italic capitals, and the acutest female octave by minuscular Italics. The whole natural scale may therefore be exhibited thus:

Gravest Male Octave.	Ordinary Male Octave.	Ordinary Female Octave.	Acutest Female Octave.
C * *D* * *EF* * *G* * *A* * *B*	C * D * EF * G * A * B	c * d * ef * g * a * b	*c* * *d* * *ef* * *g* * *a* * *bc*.
1. 2. 34. 5. 6. 7	1. 2. 34. 5. 6. 7	1. 2. 34. 5. 6. 7	1. 2. 34. 5. 6. 78.

In this exhibition, the juxtaposition of the thirds and fourths, and of the sevenths and eighths or replicates of the first degree, indicates the semitonic intervals; and the asterisks represent the tonic intervals of the natural scale, or the artificial intercalary sounds, which, as we shall presently see, it becomes necessary to substitute in those intervals.

13 Different voices require different scales.

Were all voices of the same compass, and were musical feelings satisfied with the natural scale, we might rest here. Being furnished with a key note adapted to all voices, and with instruments accurately tuned to that key note, it would be unnecessary to examine whether any other note of the natural scale could be assumed as the key note of a different scale, and if it could, whether any agreeable effect resulted from the discovery.

But the use of different scales, the key notes of which are derived from the different degrees of the natural scales, has been found not only to be one of the chief sources of the pleasure imparted by musical performances, but to be indispensably necessary from the physical inequality of voices.

The central 'c' of the scale, called in music the tenor C, can be produced by every species of voice. The gravest male voices, termed bass, can form this note, but very few notes above it. The treble, or acuter female voice also produces it, but seldom descends farther. The acuter male voices, called tenor, have this 'c' scarcely above the middle of their compass, and it is not much below the middle of that of the counter-tenor or gravest female voices. Now it is obvious that an air in the natural scale, which should rise above 'c', and fall below it in the same proportions, might be sung by the tenor or counter-tenor voice, but would be too acute for the bass voice, and too grave for the treble. Either of these voices, in order to execute the same air, must assume a different key note from 'c'; and as all the

the degrees of the scale are regulated by the key note, the air must of course be executed in a scale different from that of 'c'.

Again, suppose a singer who can sing a given air only in the scale of B, to be accompanied by an instrument tuned in the scale of 'c'. Should the lyrist begin on his own key note, he is a semitone above the key note of the singer; and should he begin on the note which is in unison with the singer's key note, the next degree is wrong, being but a semitonic interval by the instrument, and a tonic interval by the voice. In short, all the degrees but one will be found wrong. This is an evident consequence of the inequality of the semitonic to the tonic intervals; and if the tonic intervals, which we presume to be equal, be not exactly so, the discordance will be still greater.

14 **Intercalary sounds necessary.**

The remedy for this is apparently obvious. If the semitonic intervals are each equal to half of any of the tonic intervals, we need only to interpose other sounds between each two of the degrees which form the tonic intervals; and then, in place of eight degrees and seven unequal intervals, we shall have twelve degrees and twelve equal intervals, each of them equal to a semitone. An instrument thus furnished, appears to be adapted to any voice, and to resemble the modern harpischord or organ, which have twelve seemingly equal intervals in the octave. Such were the practical resources of the Greek musicians, sanctioned by the approbation of Aristoxenus, and of all those who were satisfied with the decision of the ear alone.

15 **Mathematical ratios of musical intervals.**

But philosophers and mathematicians ascertained the existence of a certain connexion between musical intervals and mathematical proportions, and gradually opened the way to the discovery that the relations of the musical scale, as naturally formed by the human voice, depend on principles equally plain and certain with the simplest geometrical propositions.

16 **Ratios of the octave fifth and fourth.**

Pythagoras is said to have discovered, that if two musical chords be in equal tension, and if one of them be half the length of the other, the short one will sound an octave above the long one; if one-third shorter, it will produce the fifth: if one-fourth shorter, it will give the fourth. Thus the relation of the key to its octave was discovered to correspond to the ratio of 2 : 1; that of the key to its fifth to be in the ratio of 3 : 2; and that of the key to its fourth to be in the ratio of 4 : 3. For instance, if a chord of a given size and tension, and 12 inches long, produce 'c', another of the same size and tension, but only six inches long, will give the octave *c*; one eight inches long will sound the fifth 'g'; and one nine inches long will produce the fourth 'f'. Now as the string of eight inches giving the fifth, and that of six inches producing the octave, are in the ratio of 4 : 3, which is that of the fourth; it follows, that the interval between the fifth and octave is a fourth: and as the chord of nine inches producing the fourth, and the octave of six inches, are in the ratio of 3 : 2, the interval between the fourth and octave must be a fifth. Thus the octave 'c' *c*, is divided into a fifth 'c g', and a fourth 'g' *c*, or into a fourth 'c f', and a fifth 'f' *c*, both in succession. The two fourths 'cf', and 'g' *c*, leave an interval 'f g', corresponding, as we have seen, to the ratio of 9 : 8.

17 **Ratio of the major third, minor third, and semitone.**

We have thus the ratios of the octave, of the fifth, and of the fourth; and it does not appear that the ancient theorists proceeded farther. They seem to have preferred the harmony of fourths and fifths to that of thirds and sixths, so essential in modern harmony. By pursuing the system of the mathematical ratios, we find that 5 : 4 gives the major third 'c e'. And the fifth 'g' being already determined by the ratio 3 : 2, we ascertain the ratio of the minor third 'e g' to be 6 : 5, which is the difference between 3 : 2 and 5 : 4. In the same way, the ratio of the third 'e' being 5 : 4, and that of the fourth 'f' being 4 : 3, we ascertain the ratio of the semitone 'e f' to be 16 : 15, or 4 : 3—5 : 4.

18 **Ratio of the major sixth and major seventh.**

A note in the ratio of 5 : 4, or that of a major third to 'f', gives 'a', the major sixth of the neutral scale; and a note in the same ratio of 5 : 4 to 'g' produces 'b', the major seventh of that scale. The ratio of 'g a' will thus be 10 : 9, and that of 'a b' 9 : 8, the same with that of 'fg'; and that of 'b' *c* will thus be 16 : 15 like 'e f'.

19 **Ratio of the major second.**

We have in this way the mathematical ratios of all the degrees of the natural scale except that of the second 'd'. Considering, however, the second to be a perfect fourth graver than the fifth, and having ascertained the fifth 'g' to be a perfect fourth below *c*, as 2 : 1 is to 3 : 2; so 3 : 2 gives 9 : 8, which we take for the ratio of the second.

20 **Aristoxenean and Pythagorean systems.**

Thus have been formed two distinct systems of intonation of the natural scale; that of mean tones and semitones, founded on the rules of Aristoxenus, and the practice of ancient artists, and that of the ratios deduced from the discoveries of Pythagoras, and the calculations of mathematicians.

21 **Circular representation of the scale.**

Plate DXXXII. fig. 1.

The difference between the Aristoxenean system of mean tones and semitones, and the Pythagorean system of mathematical ratios, will best appear from the following construction. Let the circumference of a circle (fig. 1.) be divided by dotted lines (according to the principles of Aristoxenus) into five larger and equal intervals, and two smaller intervals also equal. Let it also be divided by full lines into portions determined by means of the musical ratios. Thus let the arches CD, FG, and AB be proportional to the logarithm of 9 : 8, GA and DE to those of 10 : 9, and EF and BC to those of 16 : 15 (B). Let us divide another circle in the same manner; but instead of having its points of division marked C.D, &c. let them be marked 'key' 2d, 3d, 4th, 5th, 6th, 7th. This circle, which may be described on a piece of card, is to be placed on the other, and is to move round their common centre.

22 **Insufficiency of the natural scale for composition in different scales.**

In whatever point of the outer circle the point 'key' of the inner one be placed, it is obvious that the other points of the outer circle will shew what degrees of it, by corresponding with the other points 2d, 3d, &c. of the inner circle, will serve for degrees of the scale determined by the point 'key'. By this we see clearly the insufficiency of the degrees of the natural scale, for the performance of compositions in different scales, and the

(B) We may make CD=61°, 72; CE=155°, 9; CF=149°, 42; CG=210°, 58; CA=265°, 3; and CB=326° 48.

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the inefficacy of the Aristoxenean remedy of mean tones.

23 Galileo's discovery of aerial undulation.

But although the errors of the Aristoxeneans were demonstrated by the certainty of the ratios, and although the dependence of musical intervals on the latter be said to have been known since the days of Pythagoras, the nature of that relation remained unknown for ages. Galileo discovered that the ratios express the frequency of the aërial undulation, by which the several sounds are generated. He demonstrated that the vibrations of two chords, of the same matter and thickness, and of equal tension, will be in the ratio of their lengths, and that the number of oscillations made in a given time will be inversely as their lengths. The frequency of the sonorous undulations of the air is therefore inversely as the length of the string. Thus 2 : 1 being the ratio of the octave, the undulations which produce the acuter sound are twice as frequent as those which generate the graver. The ratio of the fifth, 3 : 2, indicates that in the same time that the ear receives three undulations from the upper sound, it receives only two from the lower. This is not peculiar to sounds produced by the vibration of strings: those produced from the vibration of bells, and from the undulation of the air in pipes, are regulated by the same law.

24 Pitch of sound determined by aerial undulations.

Thus, it is demonstrated that the pitch of musical sound is determined by the undulations of the air; and that a certain frequency of undulations produces a certain and unalterable musical note. It has been found that any noise whatever, if repeated 240 times in a second, at equal intervals, produces the tenor 'c'; if 360 times, the 'g', or fifth above. It had been imagined that musical sound was only to be produced by those regular undulations, which are occasioned by the vibrations of elastic bodies. We are assured that the same effect will be produced by any noise, if repeated not less than 30 or 40 times in a second; and that the experiment has been tried with a quill snapping against the teeth of a wheel.

25 Chords, consonant and dissonant.

By Galileo's discovery, the principles on which the just intonation of the natural scale depends, are shown to be certain and plain. To proceed in our search of an exact measure of temperament of this perfect intonation, we must consider the nature and effects of consonant and dissonant chords.

A chord is a combination of two or more simultaneous musical sounds. If the coalescence be so complete that the compound sounds cannot be distinguished, the chord is said to be consonant; if the separate sounds are distinctly heard, the chord is termed dissonant.

All consonances are pleasing, although some are more so than others. All dissonances are unsatisfactory, and some are very harsh.

26 Beats, what.

In consonances, no inequality of sound is perceptible. In dissonances, the ear is sensible of an alternate increase and diminution of the strength of the sound, without variation of pitch. This is occasioned by the alternate coincidence and bisection of the vibrations of the component sounds. For example, suppose two perfect unisons produced from two pipes each 24 inches long. Each sound has 240 vibrations in a second, either exactly coincident, or exactly alternate. In either case, the vibrations are so frequent and uniform as not to be distinguishable, and the whole appears one sound. But let one of the pipes be only 23 inches and seven-tenths long, it will give 243 vibrations in a second. Therefore the 1st, the 80th, the 160th, and the 240th vibration of the longer pipe, will coincide with the 1st, the 81st, the 162d, and the 243d of the shorter. In the instant of coincidence, the aerial agitation produced by the one vibration is reinforced by that produced by the other. The deviations from coincidence gradually increase till the 40th vibration of the longer pipe, which will commence in the middle of the 41st vibration of the shorter one. The vibrations here bisecting each other, the aerial agitations of both will be weakened. The compounded sound will consequently be stronger at the coincidences and weaker at the bisections of the vibrations. The increase of strength, which is termed the *beat*, will recur thrice in every second. Thus the vibrations are in the ratio of 80 : 81, or of a *comma;* and the compounded sound now supposed is an unison *imperfect by a comma.*

If a third pipe, tuned a perfect fifth to the longer of the two former, be sounded at the same time with the shorter, the dissonance will beat nine times in a second; and is thus shown to be a fifth imperfect by a comma.

The perfection or imperfection of any consonance may thus be ascertained with equal facility and precision: and by this method, any perfect consonance may be altered to any acquired state of temperament.

27 Beats afford an exact measure of temperament.

The theory of beats is therefore valuable, as giving us the management of a phenomenon intimately connected with perfect harmony, as affording us precise and practicable measures of all deviations from it, and as thus forming the basis of the most accurate system of temperament.

For the preparatory process of determining the exact degrees of the scale, let us attend to the following ingenious and amusing experiment.

28 Fundamental experiment.

Let two harpsichord wires be exactly tuned in unison at the pitch of the tenor 'c', to be acted on simultaneously by a wheel rubbed with rosin, like that of a *vielle.* Let a scale of 240 equal parts be described under one of the strings, equal in length to the sounding part of it, and numbered from the end at which the wheel is applied. Let a moveable bridge be placed under this string, but so as not to alter the tension of it in the least.

The two open strings being in perfect unison, without any beating whatever, let the moveable bridge be advanced slowly from the nut, while the wheel is applied to both strings. All kinds of chords, consonant and dissonant, will of course be successively heard. Between the consonances there will be a beating, which will increase as we approach the consonance, cease on our reaching it, appear again as we leave it, diminish as we recede from it, and again increase as we approach to the succeeding consonance.

After this general view, let us more particularly examine the several degrees of the scale.

29 Determination of the octave.

On placing the moveable bridge at 120, we shall hear a perfect octave, without any beating. If the division be not quite exact, there will be a little beating; but by shifting the bridge very gently to either side, the increase or diminution of the beating will guide us to the true place, where it will entirely cease.

30 Determination of the perfect fifth.

On placing the bridge at 160, the perfect concord of the

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the key and fifth will be heard. Any alteration of the bridge to either side will produce a disagreeable beating.

31 Determination of the perfect fourth.

A rapid flutter in the vicinity of 180 will cease at that point, and give place to the consonance of the key and fourth.

32 Determination of the major third.

On approaching 192, an angry waspish beating is succeeded at that point by the animating concord of the key and major third.

33 Determination of the minor third.

As we leave 192, the beating assumes a melancholy character, and ceases at 200, the place of the plaintive consonance of the key and minor third.

34 Determination of the second.

Between that point and the nut, we have only a succession of discords. As we were at a loss to ascertain the mathematical ratio of the second of the scale (art. 19), so we have some difficulty in determining its just place by the theory of beats, and the experiment under consideration. We are uncertain whether we shall fix it at a minor tone, or at a major tone above the key. Both form a harsh dissonance with the key. The major tone, however, is thought less disagreeable: it admits of five more concords in the octave than the minor; and the ratio of it 9 : 8, is that suggested by the similarity of its interval with the fifth, to the interval of the fifth and octave (art. 19). On these accounts we prefer it; and its place in the division under our precise consideration is $213\frac{1}{3}$.

35 Determination of the minor sixth.

Let the bridge now be placed near, and slowly moved to 150: the beating subsides into a consonance, slightly pleasing, that of the key and minor sixth.

36 Determination of the major sixth.

At 144, we have the agreeable concord of the key and major sixth. From 144 to 120 we hear nothing but discord.

37 Determination of the seventh.

In this interval, however, we have to find the place of the sensible note or major seventh. The ear informs us, that the interval between the major seventh and the octave, must be similar to that between the major third and the fourth. Applying to the former interval the ratio of the latter, that of 16 : 15, we place the moveable bridge at 128; for as 15 is to 16, so 120 gives 128. We also feel, that the interval between the fifth and major seventh is exactly similar to that between the key and major third, of which the ratio is 5 : 4. Now, applying the same ratio to 160, the place of the fifth, we find 5 : 4 :: 160 : 128. We thus determine 128 to be the place of the major seventh of the scale.

38 Ratios of simple intervals.

The interval or difference between the minor tone 10 : 9, and the major tone 9 : 8, is 81 : 80, termed *comma*. This interval is not employed in practical music, but must be distinctly understood by theorists, and particularly in treating of temperament.

There are therefore four descriptions of simple intervals; that is, intervals which do not include more than a major tone. These are, comma, of which the ratio is 81 : 80; hemitone, or 16 : 15; minor tone or 10 : 9; and major tone, or 9 : 8 (c).

39 Temperament necessary in keyed instruments.

We have now to consider how far the perfect intonation of the natural scale must be departed from in keyed instruments, such as the organ and harpsichord; so that the same sound may serve for different degrees of different scales.

These instruments have twelve sounds in every octave; that is, they have the eight natural degrees and four intercalary sounds, viz. between C and D, D and E, F and G, G and A, and A and B.

The purpose of these intercalary sounds is, that an air may be performed in any pitch; that is, that any sound may be taken for a key note, and that other sounds may be found to form the scale of that key note, at intervals corresponding to those of the natural scale.

Thus, if instead of C, the key note of the natural scale, we take B for the key note required; A, which is the seventh to B, will by no means answer for the seventh of the assumed scale; for the interval between A and B is a major tone, of which the ratio is 9 : 8, whereas the interval between the seventh of the scale and the octave, can only be a hemitone, the ratio of which is 16 : 15. We must therefore employ the intercalary sound between A and B, which in this employment we call A✻, or A sharp. But we shall presently see that we cannot tune even this sound in the ratio of 16 : 15 with B. For, let us take F for the key note of another scale, we find that B will not serve for the fourth of that scale, being a major tone above A the third; whereas the fourth of the scale is only a hemitone above the third. We must therefore have recourse to our intercalary sound between A and B, which

(c) The logarithmic measures of these intervals, and of the compound intervals determined in the way which we have described, are

Comma, - -	54
Hemitone, - -	280
Minor tone, - -	458
Major tone, - -	512
Minor third, - -	792
Major third, - -	969
Fourth, - -	1249
Fifth, - -	1761
Minor sixth, - -	2041
Major sixth, - -	2219
Seventh, - - -	2730
Octave, - - -	3010

The octave being thus divided into 3010 equal parts, a circle of which the circumference is divided into 301 degrees, and a concentric moveable circle having a nonius subdividing each into ten parts, will form a convenient instrument for examining all temperaments of the scale.

which we must here call B♭, or B flat, and which ought in this state to be tuned a hemitone above A, or in the ratio of 16 : 15 with that note. Now, this intercalary sound cannot be both in the ratio of 16 : 15 with A, and in the same ratio of 16 : 15 with B. This would extend the whole interval between A and B, to the ratio of about 8 : 7; whereas it should only be in that of 9 : 8. We must therefore tune the intercalary sound in such a diminished relation to A and to B, that it may serve either for A ※ or B ♭.

But, even independent of these intercalary notes, some temperament of the natural scale is necessary.

Let the four-fifths, 'c g', 'g' *d*, '*d a*', and '*a* $\bar{e}$', be tuned all perfect. Then tune the two perfect octaves from '$\bar{e}$' downwards, '$\bar{e}$ *e*', '*e* : e'. The major third 'c e' resulting from this process, will be too sharp, by a comma, or 81 : 80, and will beat 15 times in a second. The minor third 'e g' and the major sixth 'c a' will be still more discordant.

It is therefore impossible to have perfect fifths, and at the same time perfect thirds and sixths. Now, although a perfect fifth, occasionally employed, be pleasing, yet the ear does not relish a succession of perfect fifths; such a succession not only renders the harmony languid, but creates a doubt as to the key, which is unsatisfactory. On the other hand, an alternate succession of major and minor thirds and sixths constitutes the chief and most brilliant part of our harmonics. We therefore find it necessary to sacrifice somewhat of the perfect harmony of the fifths to that of the third and sixths.

It is this accommodation which is properly called TEMPERAMENT; and to this system of it, by which the fifths are diminished, and the thirds and sixths preserved perfect, we give the preference.

We have just seen that four consecutive perfect fifths compose an interval, greater, by a comma, than two octaves and a major third. But in the tuning of our instruments requiring temperament, these intervals must be rendered equal. Because, as we have seven hemitonic intervals in the fifth, twelve in the octave, and four in the major third; so the interval of four-fifths contains twenty-eight hemitonic intervals, and that of two octaves and major third contain also twenty-eight, being twenty-four for the two octaves, and four for the major third. The real difference being, however, a comma, it is plain, that if we keep the major thirds perfect, we must diminish or flatten each of the four-fifths one-fourth of a comma.

It is not easy to ascertain with perfect exactness the quarter comma by which the first fifth 'c g' is to be diminished. We shall, however, be sufficiently accurate for practical purposes if we flatten 'g' till a beating of 9 beats in four seconds is produced (D).

Having in this manner tuned 'g', we diminish the next fifth 'g' *d*, one-fourth of a comma, by flattening *d* till 'g' *d* beat half as fast again as 'c g', or $13\frac{1}{2}$ beats in four seconds (E).

The next fifth, *d a*, must be diminished in the same proportion by flattening *a* till '*d a*' beat 15 times in six seconds.

Instead of tuning upward the fifth *a* $\bar{e}$, tune downward (F) the octave *a* 'a', and then tune upward the fifth 'a' *e*, and flatten it till it beat 15 times in eight seconds.

If we take 15 seconds for the common period of all these beats, we shall find

The beats of 'c g' = 34
G 'd' = 25
'd a' = $37\frac{1}{2}$
'a *e*' = 28

On tuning downwards the octave *e* 'e' we have the major third 'c e' perfect without any beating; and we proceed, tuning upwards a fifth flattened by one-fourth of a comma, and when the beating becomes too quick, tuning downward an octave. We may do this till we reach 'b' ※, which should be the same with *c*, a perfect octave above 'c'.

It will be better, however, to stop at 'g' ※, and then to tune fifths downward from 'c' and octaves upwards, when we get too low. Thus we have 'c' F, F 'f', 'f' B♭, 'B

(D) If any concord, whose perfect ratio is $\frac{m}{n}$ (m being the greatest term of the smallest integers expressing that ratio), be tempered sharp by the fraction $\frac{p}{q}$ of a comma, and if M and N be the pulses made by the acute and grave notes of the concord during any number of seconds, the number b of beats made in the same time by this concord will be $= \frac{2\,q\,m\,N}{161\,p-q}$, or $\frac{2\,q\,n\,M}{161\,p+q}$; and if it be tempered flat, then $b = \frac{2\,q\,m\,N}{161\,p+q}$, or $\frac{2\,q\,n\,M}{161\,p-q}$. (Smith's Harm. 2d edit. p. 82, &c.). Now, let $\frac{m}{n}$ be $=\frac{3}{2}$, the ratio of the fifth; $q=1$, $p=4$; therefore, $\frac{p}{q}$ = one-fourth of a comma, and N='c' or 240 pulses in a second. Therefore, $\frac{2\,q\,m\,N}{161 \times p+q} = \frac{2 \times 3 \times 240}{161 \times 4+5} = \frac{1440}{645} = 2.25$ beats in four seconds very nearly.

(E) Because fifths, being in the ratio to each other of 3 : 2, N in this fifth = 360.

(F) The grave octaves of the upper terms of each of these tempered fifths may be determined with perfect accuracy, by making the grave octave beat with the lower term of the tempered fifth as often as the upper term does with it; for instance, by making G 'c' beat as often as 'c g', &c. For, it has been demonstrated by Dr Smith, that the upper term of a minor concord beats equally with the lower term, and with the acuter octave of that term; but that the upper term of a major concord beats twice as fast with the acuter octave of the lower term, as it does with the lower term itself. Therefore, as 'g' beats twice as fast with *c* as with 'c', and is with its grave octave G in the ratio of 2 : 1, G 'c' beats precisely as often as 'c g'.

'B♭ 'b♭', 'b♭e♭'; and this method is preferable, because the notes marked ✻ or ♭, are, when tuned in this way, in the best relation to those with which they are most frequently employed as major thirds, and the major third is the harmonic interval most in use (G).

Another system of temperament is that which divides the

(G) The process of temperament thus recommended, will be greatly facilitated by employing a pendulum made of a ball of about two ounces weight, sliding on a light deal rod, having at one end a small ring. Let this pendulum be hung by the ring on a peg, and the ball adjusted so as to make 20 vibrations in 15 seconds. This done, mark the rod at the upper edge of the ball, and adjust it in the same manner for 24, 28, 32, 36, 40, 44, and 48 vibrations. Then having calculated the beats of the different fifths, set the ball at the corresponding mark, and temper the sound till the beats keep pace exactly with the pendulum.

In order to discover, should it be necessary, the number of pulses made in a second by the tuning fork, by which we tune the tenor 'c' of our instrument, let a wire be stretched by a weight till it be unison or octave below the fork; let $\frac{1}{40}$th then be added to the weight. Being thus tempered by a comma, the contemporaneous sounding of the fork and wire will produce a beating; and on multiplying the beats by 80, the product gives the number of pulses of the fork, and consequently of the 'c' of the instrument tuned from it. But the common 'c' tuning forks are so nearly consonant to 240 pulses, that this process is scarcely necessary.

On the system of temperament now proposed, Dr Smith makes the following useful observation and deduction.

The octave consisting of five mean tones and two limmas, it is obvious that by enlarging the tones we diminish the limmas, and that the increment of the tone is two-fifths of the contemporaneous diminution of the limma. Let v represent any minute variation of this temperament: the increment of a mean tone is $2\,v$, and the contemporaneous diminution of the limma $-5\,v$. Again, if the tone be diminished by $-2\,v$, the limma will increase by $-5\,v$. Let us observe the variations of the intervals in the latter case.

The perfect fifth consisting of three tones and a limma, its variation will be $-6\,v+5\,v$ or $-v$. That is, the fifth is flattened by the quantity v. Consequently the fourth is sharpened by that quantity.

The second, being a tone above the key note, and being therefore flattened by $-2\,v$, the minor seventh is increased by $2\,v$.

The minor third consisting of a tone and a limma, its variation is $-2\,v+5\,v$ or $3\,v$. Accordingly, that of the major sixth is $-3\,v$.

The major third, or two tones, is therefore diminished by $-4\,v$. Consequently the minor sixth is increased by $4\,v$.

The major seventh, being the inversion of the limma, is therefore varied by $-5\,v$.

The tritone being diminished $-6\,v$, the false fifth is accordingly $6\,v$.

On this observation, Dr Smith has founded the following geometrical construction: Divide the straight line CE (fig. 2.) into six equal parts C*g*, *g d*, *d a*, *a* E, E *b*, *b t*, and intersect the points of division with the six parallel lines *g* G, *d* D, &c. representing the intervals arranged according to the system of mean tones and limmas.

Let any length *g* G, on the first line to the right of the line CE, represent a quarter of a comma, G will thus mark the place of the perfect fifth, and *g* that of the tempered fifth, flattened by a comma.

Take *d* D, double of *g* G, on the second parallel also on the right hand; D will mark the place of the perfect second, and *d* that of the tempered second, flattened by the half comma *d* D.

By setting off *a* A on the third parallel to the left, equal to *g* G, we have A' the perfect major sixth, and *a* the transferred major sixth, sharpened by the quarter comma A *a*.

The major third being in the system of mean tones kept perfect, the place of that degree will be *e*.

By taking *b* B on the fifth line, on the right, equal to *g* G, we find B to be the place of the perfect major seventh, and *b* to be that of the tempered major seventh flattened by the quarter comma *b* B.

And by making *t* T on the sixth line, to the right, equal to *d* D, we have the contemporaneous temperament of the tritone flattened by the half comma *t* T, and of the false fifth, sharpened by that quantity.

Any other straight line C *t'* drawn from C, across these parallels, will represent, by the intervals *g'* G, *d'* D, &c. the temperaments of another system of mean tones and limmas. Since it is plain that the simultaneous variations *g g' d d*, &c. from the former temperament are in the just proportions to each other. The straight line thus employed, (C *e'*, or C *e''*), has therefore been termed the *temperer*.

As the arrangement of the sounds of keyed instruments having only twelve keys for an octave, and meant to be used in different scales, must approach nearly to a system of mean tones, or rather mean limmas, this construction of Dr Smith's is very useful. The temperer points out, not only all the temperaments of the notes with the key note, but also the temperaments of the harmonic concords. Thus it will be seen, that the temperament of the minor third forming the interval between the major third and fifth, is in all cases the same with that of the major sixth and octave, and that the temperament of the major third forming the interval between the fourth and major sixth, is equal to that of the key and major third of the scale.

It has been proposed, in order to render Dr Smith's construction still more useful, that it should be drawn of such a size as to admit of the following supplementary scales.

1. A scale of *g* G divided into thirteen parts and a half, expressing the logarithmic measures of the temperaments mentioned in the note (C), a comma being $=54$.

2. A scale of *g* G divided into 36 parts, giving the beats made in 16 seconds by the notes *c*, *g*, when tempered by any quantity G *g'*.

3. A

the alterations between the fifths and major thirds, flattening the fifths and sharpening the major thirds; and making both beat equally fast along with the key: and since enlarging the fifth increases the tone, and consequently diminishes the limma, the intercalary sounds become thus better suited for their double service of the sharp of the note below, and the flat of the note above. Much, however, is lost in the brilliancy of the major thirds, which are the most effective concords. The fifths are not much improved, and the sixths are evidently hurt by this temperament (H).

These methods of tuning by beats are incomparably more exact than by the ear. We cannot mistake above one beat, that is, in the fifth $\frac{5}{108}$th, and in the major third $\frac{5}{180}$th of a comma.

We have offered a short view of what appears to us to be the preferable system of temperament. It has been deduced from the observations of the most able theorists, and will greatly assist a tuner; but to him there are farther necessary, as to a musical performer, a correct ear, patient attention, and long practice.

TEMPERANCE, that virtue which a man is said to possess who moderates and restrains his sensual appetites. It is often, however, used in a much more general sense, as synonymous with moderation, and is then applied indiscriminately to all the passions.

Temperance (says Mr Nelson) is the virtue that bridles our irregular desires; it is nearly allied to prudence, and has a close connection with justice; it calms revenge, and quenches the fire of unjust resentment; it checks the epicure, and stops the riotous hand of the Bacchanalian; it extinguishes or abates the flames of lust, and banishes every lawless action; it silences the flippant detracting tongue, and gives in its stead a pleasing moderation of speech; it shuts the door against avarice, and proves experimentally, that happiness does not consist in the eager pursuit or acquisition of riches, but in a contented mind; it curbs the strongest of all other passions, gaming, and distinguishes justly the absurdity and folly of making that a dangerous trade, which was only designed as a relaxation and an amusement: temperance, in a word, is the parent of many virtues; the parent of peace, prosperity, health, and joy.

Nothing can be more strange to all observation than the practice of forsaking temperance; since every day's experience proves to us, that intemperance produces the opposite to what we seek. Suppose, when a child is born, we ask the parents what it is they wish in that child; they will answer, life. But as life alone, that is, mere existence, may, by infirmity or other accidents, be very wretched, they will naturally wish for health and happiness. Well then, life, health, and happiness, are the general wishes of parents for their children. Now let us see how their wishes are likely to succeed. Their first step is usually a shameful neglect of the food of nature, the breast; the next, a blind gratification of their will; the third, an almost total neglect of their manners; and a fourth, the cherishing them in every irregular affection. Where then is the wonder that parents are disappointed? Life and health depend on proper food and other judicious management on one part; and if sick, an obedience to remedies on the other part: and happiness essentially depends in the first place on health; in the next, on the due government of our senses, affections, and passions. See here how much mankind deviate from themselves; how far they depart from their own

3. A scale of g G divided into 60 parts, for the beats of the major third C e.
4. A scale of g G divided into 72 parts, for the beats of the minor third C $e\ b$.
5. A scale of g G divided into 48 parts, for the beats of the fourth $c\,f$.
6. A scale of g G divided into 89 parts, for the beats of the minor third $g\ e$.
7. And, g G divided into 80 parts, for the beats of the major third $f\,a$.

Thus provided, and having determined by Dr Smith's construction, the temperament of 'g' 'd', 'a', 'e', 'b', and 'f', the accurate tuning of the whole octave as a system of mean tones with perfect major thirds may be completed as follows.

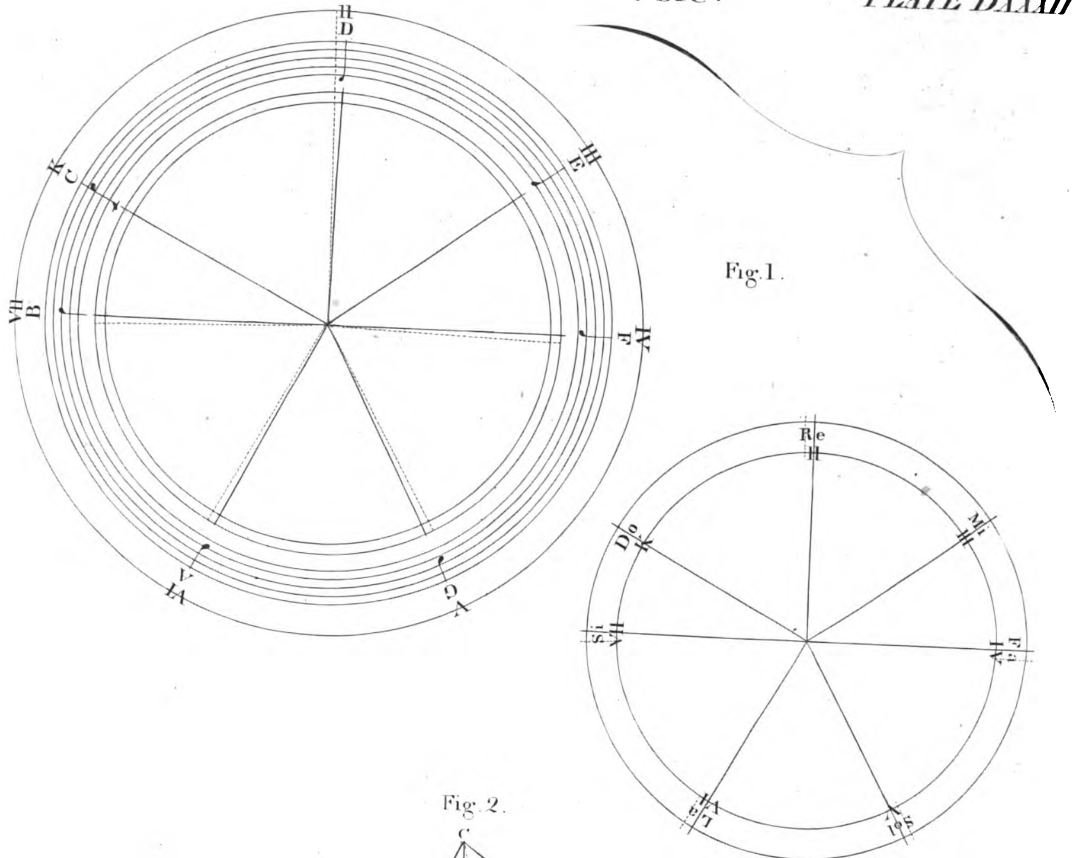
Let 'f ✱' be tuned a perfect major third above 'd'; 'g ✱' a perfect major third above 'e', and c ✱ a perfect major third above 'a'.

Let 'b ♭' be tuned a perfect major third below 'd' and 'e ♭' a perfect major third below 'g'.

(H) To adjust the temperer to this mode, let EG (fig. 2.) be divided in p, so that E p may be to p G, as 3 to 5. Then draw C p, cutting g C in g', and C t' shall be the temperer required. It will be found that E e' and G g' are each of them 32 of their respective scales.

Let therefore 'c g' beat 32 times in 16 seconds

G 'c'	32;
G 'd'	24;
G 'b'	24, and tune 'b' b;
'd' a	36, and tune a 'a'
'd' 'f ✱'	36;
'a' e	27;
'a' c ✱	27;
$e\ b$	$40\frac{5}{8}$, proving 'b' b;
$e\ g$ ✱	$40\frac{5}{8}$;
F 'c'	$21\frac{5}{7}$, and tune F 'f';
FA	$21\frac{5}{7}$, proving A 'a';
B ♭ 'f'	$28\frac{5}{8}$, and tune B ♭ 'b ♭'
'e ♭ b ♭'	$38\frac{1}{8}$;
'C' c	perfect.


II
D
III
E
IV
F
V
G
VI
A
VII
B
K
C
Re
Mi
Fa
Sol
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Si
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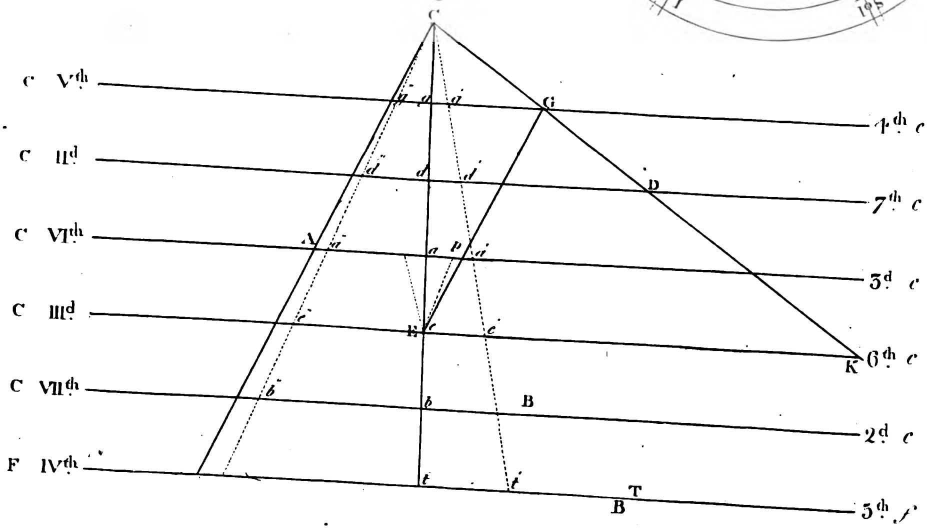
Fig. 1.

Fig. 2.


C
c Vth
c IId
c VIth
c IIId
c VIIth
F IVth
4th c
7th c
3d c
6th c
2d c
5th f
G
D
A
E
K
B
T
B

own principles. But what is the remedy? Nothing more obvious. Let parents exercise their reason in all the steps they take for their children's welfare; let them examine right and wrong; let them not only avoid passion, but labour to correct their own errors of judgement, that they may be the better enabled to prevent them in their children; but, particularly, let them fix in them the knowledge, love, and habit, of temperance.

TEMPERING, in the mechanic arts, the preparing of steel and iron, so as to render them more compact, hard, and firm; or even more soft and pliant, according to their respective occasions.

TEMPLARS, TEMPLERS, or *Knights of the Temple*, a religious order instituted at Jerusalem in the beginning of the 12th century, for the defence of the holy sepulchre and the protection of Christian pilgrims. They were first called *The poor of the Holy City*, and afterwards assumed the appellation of *Templars*, because their house was near the temple. The order was founded by Baldwin II. then king of Jerusalem, with the concurrence of the pope; and the principal articles of their rule were: That they should hear the holy office throughout every day; or that, when their military duties should prevent this, they should supply it by a certain number of pater nosters: that they should abstain from flesh four days in the week, and on Fridays from eggs and milk-meats: that each knight might have three horses, and one esquire: and that they should neither hunt nor fowl. After the ruin of the kingdom of Jerusalem about 1186, they spread themselves through Germany and other countries of Europe, to which they were invited by the liberality of the Christians. In the year 1228, this order acquired stability, by being confirmed in the council of Troyes, and subjected to a rule of discipline drawn up by St Bernard. In every nation they had a particular governor, called *master of the Temple*, or of the *militia of the Temple*. Their grand-master had his residence at Paris.

The order of Templars flourished for some time, and acquired, by the valour of its knights, immense riches and an eminent degree of military renown: but as their prosperity increased, their vices were multiplied, and their arrogance, luxury, and cruelty rose at last to such a monstrous height, that their privileges were revoked, and their order suppressed with the most terrible circumstances of infamy and severity. Their accusers were two of their own body, and their chief prosecutor Philip the Fair of France, who addressed his complaints to Clement V. The pope, though at first unwilling to proceed against them, was under a necessity of complying with the king's desire; so that, in the year 1307, upon an appointed day, and for some time afterwards, all the knights, who were dispersed throughout Europe, were seized and imprisoned, and many of them, after trials for capital crimes, were convicted and put to death. In 1312 the whole order was suppressed by the council of Vienne. A part of the rich revenues they possessed was bestowed upon other orders, especially on the knights of St John, now of Malta, and the rest confiscated to the respective treasuries of the sovereign princes in whose dominions their possessions lay.—The knights Templars, in order to justify the severity with which they were treated, were charged with apostasy to the Saracens, and holding correspondence with them, with insulting the majesty of God, turning into derision the gospel of Christ, and trampling upon the obligation of all laws human and divine. Candidates, it is said, upon admission to this order, were commanded to spit, in token of contempt, upon an image of Christ, and after admission to worship either a cat or a wooden head crowned with gold. It is farther affirmed, that, among them, the odious and unnatural act of sodomy was a matter of obligation; and they are charged with other crimes too horrible to be mentioned, or even imagined. However, though there be reason to believe, that in this order, as well as others of the same period, there were shocking examples of impiety and profligacy; yet that the whole order was thus enormously corrupt, there is no reason to believe. The pope indeed, though he acted with severity, acted with justice. He sent two cardinals to Paris, who, publishing his bull against the order, condemned those Templars who had made the voluntary confession to be burnt by a slow fire. The criminals recanted their former confessions, but acknowledged themselves worthy of death, because they had unjustly accused the order of crimes of which they were innocent. Several authors of those times wrote in defence of the order; and Boccace alleges, that its extirpation was owing to the avarice of the king of France, who coveted the rich possessions the Templars then enjoyed in France.

The king of Arragon was much pressed to treat the Templars in his kingdom as they had been treated in France; but his constant answer was, "We must be first convinced of their guilt, and it will be then time enough to talk of their punishment." The people, however, were in general so provoked against them, that they were compelled to shut themselves up in the fortresses belonging to their order, to prevent their being torn in pieces; which precaution was represented to the king of Arragon as an act of rebellion. He marched, therefore, with a corps of troops against one of these fortresses. The knight who commanded surrendered immediately, and told the king the truth, assuring him that they desired nothing but a fair trial; with which declaration the king was extremely moved, took the whole order into his protection, and forbade any to abuse or insult them under the heaviest penalties. At the same time he declared he was ready to receive any informations against them that were supported by proofs; but if the informers failed therein, he would punish them as they deserved.

These facts plead strongly for the innocence of the Templars, or at least they prove that their guilt must have been exaggerated; and if we add, that many of the accusations advanced against them flatly contradict each other, and that many members of this unfortunate order solemnly avowed their innocence while languishing under the severest tortures, and even with their dying breath—it would seem probable, that King Philip set on foot this bloody tragedy, with a view to gratify his avarice, and glut his resentment against the Templars, and especially against their grand-master, who had highly offended him. The principal cause of his invincible hatred against them was, that in his quarrel with Boniface VIII. the knights espoused the cause of the pope, and furnished him with money to carry on the war. They originally wore a white habit, with red crosses sewed upon their cloaks as a mark of distinction.

TEMPLE, SIR WILLIAM, was born in London in the

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the year 1628. The family from which he sprung was ancient, and is said to have assumed the surname of Temple from the manor of Temple, in the hundred of Sparken-Hall, in Leicestershire. He was first sent to school at Penschurst, in Kent, under the care of his uncle, the celebrated Dr Hammond, then minister of that parish; but at the age of ten he was removed thence to a school at Bishop-Stortford, in Hertfordshire. When he had acquired a sufficient knowledge of the Greek and Latin, he returned home at the age of fifteen; and, two years after, he went to Cambridge, where he was placed under the tuition of the learned Dr Cudworth, then fellow of Emanuel college. His father, Sir John Temple, being a statesman, seems to have designed him for the same way of life; and on this account, after residing at Cambridge two years, which were principally spent in acquiring a competency of French and Spanish, both languages exceedingly useful for his intended pursuits, he was sent abroad to finish his education.

Mr Temple began his travels by visiting France in 1648. As he chose to pass through the Isle of Wight, where his majesty was detained a prisoner, he there accidentally met with the second daughter of Sir Peter Osborn of Chicksand, in Bedfordshire, then governor of Guernsey for the king; and his lady being on a journey with her brother to St Maloes, where their father then was, our young traveller joined their party. This gave rise to an honourable attachment, which, at the end of seven years, concluded in a happy marriage. Having resided two years in France, and learned the French language perfectly, Mr Temple made a tour through Holland, Flanders, and Germany, during which he became completely master of the Spanish. In 1654 he returned from the continent, and, marrying Miss Osborn, passed his time in retirement with his father, his two brothers, and a sister, then in Ireland, happy in that perfect harmony which has been so often remarked in their family.

As he rejected all offers made him of employment under Cromwell, the five years which he lived in Ireland were spent chiefly in improving himself in history and philosophy; but at the Restoration, in 1660, being chosen a member of the convention there, while others were trying to make their court to the king, Mr Temple opposed the poll-bill with so much spirit, that his conduct soon attracted the attention of the public, and brought him into notice. In the succeeding parliament, in 1661, he was elected with his father for the county of Carlow; and in the year following, he was chosen one of the commissioners to be sent from that parliament to the king, which gave him an opportunity of waiting on the duke of Ormond, the new lord lieutenant, then at London. Soon after he went back to Ireland, but with a resolution of quitting that kingdom, and of removing with his family to England.

On his return he met with a very favourable reception from the duke of Ormond; and soon acquired such a considerable share in his esteem, that the duke complained of him as the only man in Ireland that had never asked any thing from him. When he mentioned his design of carrying his family to England, his grace said, that he hoped he would at least give him leave to write in his favour to the two great ministers, Clarendon then lord chancellor, and the earl of Arlington, who was secretary of state. This the duke did in such strong terms, as procured him the friendship of these two noblemen, as well as the good opinion of the king. Mr Temple, however, made no other use of this advantage than to tell Lord Arlington, that if his majesty had any employment abroad, which he was fit for, he should be happy to undertake it; but, at the same time, he requested that he might not be sent into any of the northern climates, to which he had a very great aversion. Lord Arlington replied, he was very sorry he had made such an objection, as there was no other employment then undisposed of except that of going envoy to Sweden. However, in 1665, about the beginning of the first Dutch war, Lord Arlington sent a messenger to acquaint him that he must immediately come to his house; which he did, and found that his lordship's business was to tell him, that the king had occasion to send some person abroad upon an affair of the utmost importance, and that he had resolved to make him the first offer; but that he must know, without delay, and without telling him what it was, whether he would accept of it, and that he must be ready to set out in two or three days, without mentioning it to any of his friends. After a little consideration, Mr Temple told his lordship, that, as he took him to be his friend, and as he had advised him not to refuse, as it would be an entrance into his majesty's service, he should consult no farther. This business was to carry a secret commission to the bishop of Munster; which he set out with on the second of August, and executed it so much to the satisfaction of Charles II. that, on his return to Brussels, his majesty appointed him resident there, and created him a baronet. As Brussels was a place which he had long wished to reside at, in April 1666 he sent for his family; but, before their arrival, he had been again obliged to depart upon business to the prelate's court: for the bishop having listened to terms of accommodation with France, Sir William wrote two letters to dissuade him from that alliance; and these not having the desired effect, he went in disguise to Munster, where, though he arrived too late to secure the prince in his first engagement, yet he prevailed on him to permit five or six thousand of his best troops to enter into the Spanish service. In this journey he passed for a Spanish envoy, having twenty Spanish guards to attend him. In this manner he first went to Dusseldorp, where the duke of Newburgh, though in the French interest, gave him a guard to Dortmund; but when he reached that place, finding the gates shut, he was forced to proceed to a village, at the distance of a league, which being full of Brandenburgh troops, he was under the necessity of lodging in a barn, upon a straw bed, with his page for a pillow. Next day he was entertained at a castle belonging to the bishop of Munster, by one Gorges a Scotch lieutenant-general in that prelate's service, with what he calls a very episcopal way of drinking. The general coming to the large hall, in which stood a great many flaggons ready charged, he called for wine to drink the king's health. A silver bell, that might hold about two quarts, was upon this brought him; and, as soon as he received it, he pulled out the clapper, and giving it to Sir William, to whom he intended to drink, ordered the bell to be filled. When he was done, he drank off the contents to his majesty's health; and asked Sir William for the clapper, put it on, and turning down the bell, rang it, to show that he had drank fair, and

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and left nothing in it. He then took out the clapper, desired Sir William to give it to whomsoever he pleased; and, ordering the bell to be filled again, presented it to Sir William: but as the latter seldom used to drink, he had generally some gentleman with him to supply his place in this respect whenever it might be necessary. Having finished his business at Munster, he returned to Brussels, where he passed a year with great pleasure and satisfaction.

Two months after the conclusion of the peace with the Dutch at Breda, Sir William's sister, who resided with him at Brussels, being very desirous of seeing Holland, he went thither incognito to gratify her desire; but while he was at the Hague, he paid a private visit to Mr De Witt, in which he laid the foundation of that close intimacy which afterwards subsisted between them.

In the spring of 1667, a new war breaking out between France and Spain, which exposed Brussels to the danger of falling into the hands of the former, Sir William sent his lady and family to England; but he himself remained there with his sister till the Christmas following, when he was ordered by the king to come over privately to London. Taking the Hague in his way, he paid another visit to De Witt, and, pursuant to his instructions, proposed those overtures to him which produced the triple alliance. Soon after his arrival at the British court, he returned, on the 16th of January 1668, with the character of envoy extraordinary and plenipotentiary to Holland; where a conference being opened, he brought that treaty to a perfect conclusion in the short space of five days. The ratifications of this alliance being exchanged on the 15th of February, he repaired to Brussels; and a treaty being set on foot between France and Spain at Aix-la-Chapelle, he set out for that place on the 24th of April in quality of his majesty's ambassador extraordinary and mediator. Here he arrived on the 27th: and it was chiefly owing to his assistance that the Spaniards were brought to sign the articles of that peace on the second of May. This service being completed, he returned to Brussels, with a view of remaining there in his former station of resident; but he received letters from the earl of Arlington, with the king's order to continue as ambassador, and to serve his country in that quality in Holland, as on account of the late alliances, his majesty was resolved to renew a character which the crown of England had discontinued there since the time of King James. Sir William being now left at liberty to return to England, embraced the opportunity; and, upon his arrival at London, he was received with every possible demonstration of favour both by the king and the court.

Setting out again for Holland, with his new character of the king's ambassador, he arrived at the Hague in the end of August 1668. Here he enjoyed the confidence of that great minister De Witt, and lived in great intimacy with the prince of Orange, who was then only eighteen years of age; but, in September 1669, he was hurried back to England by Lord Arlington, who ordered him to put his foot in the stirrup as soon as he should receive his letter. When Sir William waited on the earl, he found that he had not one word to say to him; for, after making him attend a long time, he only asked a few indifferent questions respecting his journey. Next day he was received as coolly by the king; but the secret soon came out, and he pressed to return to the Hague, and pave the way for a war with Holland. This, however, he excused himself from having any hand in; which so much provoked the lord treasurer Clifford, that he refused to him an arrear of two thousand pounds due from his embassy. Disgusted with Arlington's behaviour, which was so unlike the friendship he had formerly professed, Sir William now retired to his house at Sheen near Richmond, in Surry; and in his retreat, when free from the hurry of business, he wrote his Observations on the United Provinces, and one part of his Miscellanies, in the time of the second Dutch war. About the end of summer, however, 1673, the king wishing to put an end to the war, sent for Sir William, and desired him to go to Holland to negociate a peace; but powers having been sent from thence at this time to the Marquis de Fresno, the Spanish ambassador at London, Sir William was ordered to confer with him; and a treaty was accordingly concluded in three days, and the point carried respecting the superiority of the British flag, which had been so long contested. In June 1674 he was again sent ambassador to Holland to offer the king's mediation between France and the confederates, then at war, which was accepted not long after; Lord Berkeley, Sir William Temple, and Sir Leoline Jenkins, being declared ambassadors and mediators; and Nimeguen, which Sir William had proposed, was at length agreed upon by all parties to be the place of treaty. During his stay at the Hague, the prince of Orange, who was fond of the English language, and of the plain English way of eating, constantly dined and supped once or twice a week at his house; and by this familiarity he so much gained the prince's confidence and esteem, that he had a considerable hand in his marriage with the Princess Mary, daughter of James II.

In July 1676 he removed his family to Nimeguen, where he spent the remainder of that year without making any progress in the treaty; and the year following his son was sent over with letters from the lord treasurer, ordering him to return, and succeed Mr Coventry as secretary of state. In consequence of this order, Sir William came over to England in the spring of 1677; and though the affair of the secretary's place was dropped at his desire, he did not return to Nimeguen that year. About this time, the prince having the king's leave to come over, he soon after married the Princess Mary; and this gave occassion for a new coolness between Lord Arlington and Sir William, as he and the lord-treasurer Osborn, who was related to Sir William's lady, were only privy to that affair. After the prince and princess were gone to Holland, as the court always seemed inclined to favour France, the king wished to engage Sir William in some negociations with that crown: but he was so ill satisfied with this proposal, that he offered to give up all pretensions to the office of secretary; and desiring the lord-treasurer to acquaint his majesty with his intentions, retired to Sheen, in hopes of being taken at his word. Upon a discovery, however, of the French designs not to evacuate the Spanish towns agreed by the treaty to be delivered up, the king commanded him to go upon a third embassy to the states; with whom he concluded a treaty: by which England engaged, in case France refused to evacuate the towns in forty days, to declare war immedi-

 ately

ately against that nation; but before half that time was elapsed, one Du Cross was sent from the English court to Holland upon a business which damped all the good humour excited by the treaty there, and which produced such sudden and astonishing changes in this country, as gave Sir William a distaste for all public employments.

In 1679 he went back to Nimeguen, where the French delayed to sign the treaty till the last hour; but having concluded it, he returned to the Hague, whence he was soon after sent for to enter upon the secretary's office, which Mr Coventry at length resolved to resign. He accordingly come over, and went to court, as all his friends hoped, with a full intention of assuming his office; but he started some difficulty, because he had not a seat in the house of commons, thinking that, by his not being a member, the public business would suffer at such a critical time, when the contests between the two parties ran so high that the king thought fit to send the duke of York into Flanders, and the parliament to put the lord-treasurer Danby into the Tower. After this his majesty still pressed Sir William to be secretary of state; using as an argument for his compliance, that he had nobody to consult with at a time when he had the greatest need of the best advice. Notwithstanding all this, Sir William declined the king's offer, advising him to choose a council in whom he could confide, and upon whose abilities he could depend. This advice the king followed; and the choice of the persons being concerted between his majesty and Sir William, the old council was dissolved four days after, and the new one established, of which the latter was a member.

In 1680 the councils began again to be changed, on the king's illness, at the end of summer, and the duke of York's return privately to court. In this juncture Sir William, endeavouring to bring to the king's favour and business some persons to whom his majesty had taken a dislike, if not an aversion, he met with such treatment from them as gave him a fresh distaste to the court, at which he seldom made his appearance; so that he resided principally at Sheen. Soon after this the king sent for him again; and having proposed that he should go as ambassador into Spain, Sir William consented: but when his equipage was almost ready, and part of the money paid down for it, the king changed his mind, and told him that he would have him defer his journey till the end of the session of parliament, in which he was chosen a member for the university of Cambridge. In this session the spirit of party ran so high that it was impossible to bring the house to any kind of temper. The duke was sent into Scotland; but this would not satisfy them, nor any thing but a bill of exclusion; which Sir William strenuously opposed, saying, that "His endeavour ever should be to unite the royal family, and that he would never enter into any councils to divide them." Not long after this period, the parliament being dissolved by his majesty, without the advice of his privy council, and contrary to what he had promised, Sir William made a bold speech against it; for which he was very ill used by some of those friends who had been most earnest in promoting the last change in the ministry. Upon this he grew quite tired of public business, declined the offer he had of again serving for the university in the next parliament, that was soon after called, and met at Oxford; and seeing his majesty resolved to govern without his parliament, and to supply his treasury through another channel, he retired to Sheen a few days after, whence he sent word by his son, that "he would pass the rest of his days like a good subject, but would never more meddle with public affairs." From that time Sir William lived at this place till the end of that reign and for some time in the next; when having purchased a small seat, called *Moor Park*, near Farnham in Surry, which he conceived a great fondness for, on account of its solitude and retirement, and its healthy and pleasant situation, and being much afflicted with the gout, and broken with age and infirmities, he resolved to spend the remainder of his life in this agreeable retreat. In his way thither, therefore, he waited on King James, who was then at Windsor, and begged his favour and protection to one "that would always live as a good subject, but, whatever might happen, never again enter upon any public employment;" desiring his majesty to give no credit to any thing he might hear to the contrary. The king, who used to say that Sir William Temple's character was always to be believed, promised him whatever he desired, gently reproached him for not entering into his service, which, he said, was his own fault; and kept his word as faithfully to Sir William as Sir William did to his majesty, during the surprising turn of affairs that soon after followed by the arrival of the prince of Orange. At the time of this happy revolution, in 1688, Moor Park becoming unsafe, as it lay in the way of both armies, he went back to the house at Sheen, which he had given up to his son; to whom he refused leave, though importunately begged, to go and meet the prince of Orange at his landing: but after King James's abdication, when the prince reached Windsor, he went thither to wait upon his highness, and carried his son along with him. The prince pressed him to enter into his service, and to be secretary of state; but his age and infirmities confirming him in the resolution he had made not to meddle any more with public affairs, he was satisfied that his son alone should enjoy his majesty's favour. Mr John Temple was upon this appointed secretary at war; but he had hardly been a week in that office, when he resolved to put an end to his own existence; which he did on the 14th of April 1689, by throwing himself out of a boat, hired for that purpose, in shooting London-bridge; having first put stones into his pocket to make him sink speedily.

In 1694 Sir William had the misfortune to lose his lady, who was a very extraordinary woman, as well as an affectionate wife. He was then considerably turned of sixty; at which age he practised what he had so often declared to be his opinion, that "an old man ought then to consider himself of no farther use in the world except to himself and his friends." After this he lived four years very much afflicted with the gout; and his strength and spirits being worn out by the infirmities of age, he expired in the month of January 1698. He died at Moor-Park, where his heart was buried in a silver box under the sun dial in his garden, opposite to a window from which he used to contemplate and admire the works of nature, with his sister, the ingenious Lady Gifford. This was according to his will; in pursuance of which his body was privately interred in Westminster Abbey, and a marble monument erected in 1722, after the

the death of Lady Gifford, who resembled him in genius as well as in person, and left behind her the character of one of the best and most constant friends in the world.

Sir William Temple's principal works are, 1. Memoirs from 1672 to 1692: They are very useful for those who wish to be acquainted with the affairs of that period. 2. Remarks upon the State of the United Provinces. 3. An Introduction to the History of England: This is a Sketch of a General History. 4. Letters written during his last embassies. And, 5. Miscellanies, which contain a great many curious pieces that display considerable depth of thought. He was an accomplished gentleman, a sound politician, a patriot, and a great scholar. And if this great idea should perchance be shaded by some touches of *vanity* and *spleen*, the reader will be so candid as to consider, that the greatest, wisest, and the best of men, have still some failings and imperfections which are inseparable from human nature.

TEMPLE, *Templum*, a public building, erected in honour of some deity, either true or false; and wherein the people meet to pay religious worship to the same. The word is formed from the Latin *templum*, which some derive from the Greek τιμενος, signifying the same thing; and others from τεμνω, *abscindo*, "I cut off, I separate," in regard a temple is a place separated from common uses; others with more probability derive it from the old Latin word *templare*, "to contemplate." It is certain the ancient augurs gave the name *templa* to those parts of the heavens which were marked out for the observation of the flight of birds. Their formula was this: *Templa tesqua sunto.* Temples were originally all open, and hence received their name. See Phil. Trans. N° 471. sect. 5. where we have an account of an ancient temple in Ireland of the same sort as our famous Stonehenge. The word *templum*, in its primary sense among the old Romans, signified nothing more than a place set apart and consecrated by the augurs, whether inclosed or open, in the city or in the fields.

Clemens Alexandrinus and Eusebius refer the origin of temples to the sepulchres built for the dead. This notion has been lately illustrated and confirmed by a variety of testimonies by Mr Farmer in his Treatise on the Worship of Human Spirits, p. 373, &c. Herodotus and Strabo will have the Egyptians to have been the first who built temples to the gods. The first erected in Greece is ascribed to Deucalion, by Apollonius, Argonaut. lib. iii. In antiquity we meet with many people who would not build any temples to their gods for fear of confining them to too narrow bounds. They performed their sacrifices in all places indifferently, from a persuasion that the whole world is the temple of God, and that he required no other. This was the doctrine of the magi, followed by the Persians, the Scythians, the Numidians, and many other nations mentioned by Herodotus, lib. i. Strabo, lib. xv. and Cicero in his second oration against Verres.

The Persians, who worshipped the sun, believed it would wrong his power to inclose him in the walls of a temple, who had the whole world for his habitation; and hence, when Xerxes ravaged Greece, the magi exhorted him to destroy all the temples he met with.

The Sicyonians would build no temple to their goddess Coronis; nor the Athenians, for the like reason, erect any statue to Clemency, who, they said, was to live in the hearts of men, not within stone walls.

The Bithynians had no temples but the mountains to worship on; nor had the ancient Germans any other but the woods.

Even some philosophers have blamed the use and building of temples, particularly Diogenes, Zeno, and his followers the Stoics. But it may be said, that if God hath no need of temples, men have need of places to meet in for the public offices of religion: accordingly temples may be traced back even into the remotest antiquity. See *Hospinian de Origine Templorum.*

The Romans had several kinds of temples; whereof those built by the kings, &c. consecrated by the augurs, and wherein the exercise of religion was regularly performed, were called, by way of eminence, *templa*, "temples." Those that were not consecrated, were called *ædes*. The little temples, that were covered or roofed, they called *ædiculæ*. Those open, *sacella*. Some other edifices, consecrated to particular mysteries of religion, they called *fana* and *delubra*.

All these kinds of temples, Vitruvius tells us, had other particular denominations, according to the form and manner of their construction, as will be hereafter specified.

Indeed the Romans outdid all nations with regard to temples: they not only built temples to their gods, to their virtues, to their diseases, &c. but also to their emperors, and that in their life time; instances whereof we meet with in medals, inscriptions, and other monuments. Horace compliments Augustus hereupon, and sets him above Hercules and all the heroes of fable; because those were admitted into temples only after their death, whereas Augustus had his temples and altars while living.

Præsenti tibi maturos largimur honores;
Jurandasque tuum per nomen ponimus aras.
Epist. ad Aug.

Suetonius, on this occasion, gives an instance of the modesty of that emperor, who would allow of no *temples* being erected to him in the city; and even in the provinces, where he knew it was usual to raise temples to the very proconsuls, refused any but those erected in the name of Rome as well as his own.

The most celebrated temples among the Romans were the Capitol and Pantheon. They had also the temple of Saturn, which served for the public treasury; and the temple of Janus.

The temple at Jerusalem was similar in its plan to the TABERNACLE. The first temple was begun by Solomon about the year of the world 2992, and before Christ 1012 according to some chronologers, and finished in eight years. Great mistakes have been committed respecting the dimensions of this temple, by confounding the emblematical description of Ezekiel with the plain account of it in the books of Kings and Chronicles. It consisted of the holy of holies, the sanctuary, and a portico. The holy of holies was a square room of 20 cubits; the sanctuary, or holy place, was 40 cubits long and 20 broad, consequently the length of both these together was 60 cubits. The portico, which stood before the sanctuary, was 20 cubits long and 10 cubits broad. Whether the portico was separated by a wall from

Temple.

from the rest of the temple or not, is not mentioned in scripture. If it was, the whole length of the temple, computing the cubit at 22 inches, did not exceed 110 feet in length and 36 feet 8 inches in breadth. In the portico stood the two brazen pillars called *Jachin* and *Boaz*, which, upon comparing and reconciling the seemingly different accounts in different places, appear to have been 40 cubits high and about 4 cubits diameter. The court probably at first extended all round the temple. Now we are told, that the court about the tabernacle was 100 cubits long and 50 broad; and as Solomon made every part of the temple about twice as large as the corresponding part in the tabernacle, we have reason to conclude, that the court around the temple was 200 cubits long and 100 broad. According to this description, which is taken from the scripture history, the temple of Solomon was by no means so large, as it is commonly represented. Still, however, it was very magnificent in size and splendid in ornament. It was plundered of its treasures in the reign of Rehoboam, and repaired by Joash; it was again spoiled in the time of Ahaz and of Hezekiah; and after being restored by Josiah, was demolished by Nebuchadnezzar in the year of world 3416, after it had stood 476 years according to Josephus, and according to Usher 428 years.

The second temple was built by the Jews, after their return from the Babylonish captivity, under the direction and influence of Zerubbabel their governor, and of Joshua the high-priest, with the leave and encouragement of Cyrus the Persian emperor, to whom Judea was now become a tributary kingdom. According to the Jews, this temple was destitute of five remarkable appendages, which were the chief glory of the first temple; viz. the ark and mercy-seat, the Shechinah, the holy fire on the altar, which had been first kindled from heaven, the urim and thummim, and the spirit of prophecy. This temple was plundered and profaned by Antiochus Epiphanes, who also caused the public worship in it to cease; and afterwards purified by Judas Maccabæus, who restored the divine worship; and after having stood 500 years, rebuilt by Herod, with a magnificence approaching to that of Solomon's. Tacitus calls it *immensæ opulentiæ templum*; and Josephus says, it was the most astonishing structure he had ever seen, as well on account of its architecture as its magnitude, and likewise the richness and magnificence of its various parts and the reputation of its sacred appurtenances. This temple, which Herod began to build about 16 years before the birth of Christ, and so far completed in nine years and a half as to be fit for divine service, was at length destroyed by the Romans on the same month and day of the month on which Solomon's temple was destroyed by the Babylonians.

Maurice's Indian Antiquities, vol. iii. p. 352.

The Indian temples, or pagodas, are sometimes of a prodigious size. They are commonly erected near the banks of the Ganges, Kistna, or other sacred rivers, for the benefit of ablution in the purifying stream. Where no river flows near the foot of the pagoda, there is invariably in the front of it a large tank or reservoir of water. These are, for the most part, of a quadrangular form, are lined with freestone or marble, have steps regularly descending from the margin to the bottom, and Mr Crauford observed many between three and four hundred feet in breadth. At the entrance of all the more considerable pagodas there is a portico, supported by rows of lofty columns, and ascended by a handsome flight of stone steps; sometimes, as in the instance of Tripetti *, to the number of more than a hundred. Under this portico, and in the courts that generally inclose the whole building, an innumerable multitude assemble at the rising of the sun; and, having bathed in the stream below, and in conformity to an immemorial custom over all the East, having left their sandals on the border of the tank, impatiently await the unfolding of the gates by the ministering brahmin. The gate of the pagoda universally fronts the east, to admit the ray of the solar orb; and, opening, presents to the view an edifice partitioned out, according to Mr Thevenot in his account of Chitanagar, in the manner of the ancient cave-temples of Elora, having a central nave or body; a gallery ranging on each side; and, at the farther end, a sanctuary, or chapel of the deity adored, surrounded by a stone balustrade to keep off the populace. Those who wish to peruse a more particular account of the Indian temples may consult Maurice's Indian Antiquities. See also PAGODA and SERINGHAM.

Crauford's Sketches, vol. i. p. 106.

* *Voyage des Indes*, tom. iii.

TEMPLE, in *Architecture*. The ancient temples were distinguished, with regard to their construction, into various kinds; as, *Temple in antæ*, *Ædes in antis*. These, according to Vitruvius, were the most simple of all temples, having only angular pilasters, called *antæ* or *parastatæ*, at the corners, and two Tuscan columns on each side of the doors. *Temple tetrastyle*, or simple *tetrastyle*, was a temple that had four columns in front, and as many behind. Such was the temple of Fortuna Virilis at Rome. *Temple prostyle*, that which had only columns in its front or foreside; as that of Ceres at Eleusis in Greece. *Temple amphiprostyle*, or *double prostyle*, that which had columns both before and behind, and which was also tetrastyle. *Temple periptere*, that which had four rows of insulated columns around, and was hexastyle, i. e. had six columns in front; as the temple of Honour at Rome. *Temple diptere*, that which had two wings and two rows of columns around, and was also octostyle, or had eight columns in front; as that of Diana at Ephesus.

TEMPLES, among us denote two inns of court in London, thus called, because anciently the dwelling-house of the knights templars. At the suppression of that order, they were purchased by the professors of the common law, and converted into *hospitia* or inns. They are called the *inner* and *middle temple*, in relation to Essex-house; which was also a part of the house of the templars, and called the *outer temple*, because situated without Temple-Bar. In the middle temple, during the time of the templars, the king's treasure was kept; as was also that of the kings of France in the house of the templars at Paris. The chief officer was the master of the temple, who was summoned to parliament in 47 Hen. III. and from him the chief minister of the temple-church is still called *master of the temple*.

TEMPLES, in *Anatomy*, a double part of the head, reaching from the forehead and eyes to the two ears. The temples are chiefly formed of two bones called *ossa temporis*. These parts, according to physicians, were called *tempora*, from their showing the age or time of a man by the colour of the hair, which turns white in this part before any other; which Homer seems to have been aware of, by his calling men *poliocrotaphi*, q. d. "grey-templed."

TEMPORAL,

Temporal, Temporalities.

TEMPORAL, a term generally used for secular, as a distinction from ecclesiastical. Thus we say temporal lords, and spiritual or ecclesiastical lords.

TEMPORALITIES *of Bishops*, are the revenues, lands, tenements, and lay-fees, belonging to bishops, as they are barons and lords of parliament.

The custody of the temporalities of bishops forms a branch of the king's ordinary revenues (see REVENUE). These, upon the vacancy of the bishopric, are immediately the right of the king, as a consequence of his prerogative in church matters: whereby he is considered as the founder of all archbishoprics and bishoprics, to whom, during the vacancy, they revert. And for the same reason, before the dissolution of abbeys, the king had the custody of the temporalities of all such abbeys and priories as were of royal foundation (but not of those founded by subjects), on the death of the abbot or prior. Another reason may also be given why the policy of the law hath vested this custody in the king; because, as the successor is not known, the lands and possessions of the see would be liable to spoil and devastation if no one had a property therein. Therefore the law has given the king, not the temporalities themselves, but the custody of the temporalities, till such time as a successor is appointed; with power of taking to himself all the intermediate profits, without giving any account to the successor; and with the right of presenting (which the crown very frequently exercises) to such benefices and other preferments as fall within the time of vacation. This revenue is of so high a nature, that it could not be granted out to a subject, before or even after it accrued: but now, by the statute 15 Edw. III. stat. 4. cap. 4. and 5. the king may, after the vacancy, lease the temporalities to the dean and chapter; saving to himself all advowsons, escheats, and the like. Our ancient kings, and particularly William Rufus, were not only remarkable for keeping the bishoprics a long time vacant, for the sake of enjoying the temporalities, but also committed horrible wastes on the woods and other parts of the estate; and to crown all, would never, when the see was filled up, restore to the bishop his temporalities again, unless he purchased them at an exorbitant price. To remedy which, King Hen. I. granted a charter at the beginning of his reign, promising neither to sell, nor let to farm, or take any thing from, the domains of the church, till the successor was installed. And it was made one of the articles of the great charter, that no waste should be committed in the temporalities of bishoprics, neither should the custody of them be sold. The same is ordained by the statute of Westminster the first; and the statute 14 Edward III. stat. 4. cap. 4. (which permits a lease to the dean and chapter) is still more explicit in prohibiting the other exactions. It was also a frequent abuse, that the king would, for trifling or no causes, seize the temporalities of bishops, even during their lives, into his own hands: but this is guarded against by statute 1 Edw. III. stat. 2. cap. 2.

Blackst. Comment. vol. i.

This revenue of the king, which was formerly very considerable, is now by a customary indulgence almost reduced to nothing; for, at present, as soon as the new bishop is consecrated and confirmed, he usually receives the restitution of his temporalities quite entire and untouched from the king; and then, and not sooner, he has a fee-simple in his bishopric, and may maintain an action for the profits.

Temporalities ‖ Tenedos.

TENACITY, in *Natural Philosophy*, that quality of bodies by which they sustain a considerable pressure or force of any kind without breaking. It is the quality opposite to fragility or brittleness. See STRENGTH *of Materials*.

TENACULUM, in *Surgery*, an instrument used in amputation, for pulling out bleeding vessels that are to be tied by ligatures. See SURGERY.

TENAILLES and TENAILLIONS. } See FORTIFICATION, Sect. I. § 3. and 5.

TENANT, one that holds lands or tenements of some lord or landlord, by rent, fealty, &c. See TENURE.

TENAWIT. See LOXIA, ORNITHOLOGY *Index*.

TENCH. See CYPRINUS, ICHTHYOLOGY *Index*.

TENDER, a small ship in the service of men of war, for carrying men, provisions, or any thing else that is necessary.

TENDONS, in *Anatomy*, are white, firm, and tenacious parts, contiguous to the muscles, and usually forming their extremities. See ANATOMY, N° 85.

TENEBRIO, in *Natural History*, a genus of insects belonging to the order of coleoptera. See ENTOMOLOGY *Index*.

TENEDOS, in *Ancient Geography*, an island on the coast of Troas, at the distance of 40 stadia from the continent, and 80 in compass; with a cognominal Æolian town, and a temple of Apollo Smintheus. Its origin is derived from Tennes or Tenes, who being exposed in a coffer or bog by his father Cygnus the Thracian, at the instigation of the mother-in-law, was by fate carried to this island, made king of it, and at length worshipped as a god on account of his virtues. The island was famous for its earthen ware, for which purpose it had an excellent red clay; and hence Bochart would derive the appellation from *tinedom*, a "red clay." *Tenedia securis*, is a proverbial saying to denote severity; from a law there passed, that persons found in the act of adultery should be put to death; a severity executed on the king's son; and therefore, in the coins of Tenedos, on one side are two heads, in memorial of the king and his son, and on the reverse an axe, (Aristotle). This island still retains its ancient name; and is one of the smallest islands of the Archipelago, situated near the coast of Lesser Asia, west of the ruins of Troy. It is chiefly rocky, but fertile, being remarkable for producing the best Muscadine wine in the Levant; and its position, thus near the mouth of the Hellespont, has given it importance in all ages; vessels bound towards Constantinople finding shelter in its port, or safe anchorage in the road, during the Etesian or contrary winds, and in foul weather. The emperor Justinian erected a magazine to receive the cargoes of the corn ships from Alexandria, when detained there. This was a lofty building, 280 feet long, and 90 broad. The voyage from Egypt was rendered less precarious, and the grain preserved until it could be transported to the capital. Afterwards, during the troubles of the Greek empire, Tenedos experienced a variety of fortune. The pirates, who infested these seas, made it for many years their place of rendezvous; and Othman seized it in 1302, procured vessels, and thence subdued the other islands of the Archipelago.

In

Tenedos, Teneriff.

It has continued in the possession of the Turks ever since: and on the eastern side is a pretty large town, seated at the foot of a mountain, with a fine harbour commanded by a castle. E. Long. 26. 0. N. Lat. 39. 42.

TENERIFF, an island of Africa, and one of the Canaries, being the most considerable for riches, trade, and extent. It lies to the south of the island of Salvages, to the west of the Grand Canary, to the north of the island of Gomera, and to the east of that of Palma. It is of a triangular form, being about 45 miles in length and 20 in breadth; and in the centre is the famous *peak*, called by the natives *El Pico de Teyde*, which in clear weather may be seen at the distance of 120 or even 140 miles, like a thin blue vapour very little darker than the sky.

The most frequented harbour is called *Santa Cruz*, which is on the south side of the island, and where ships with good anchors and cables may be safe in all weathers. At this port is the principal commercial town in the island, called also *Santa Cruz*, in the middle of which is a mole, built at a vast expence, for the convenience of landing; between the mole and the town is a fort called *St Philip's*, and near it is a steep rocky den or valley, beginning at the sea shore, and running far inland, which would render the attack of an enemy very difficult; there are also other forts for its defence, all joined together by a thick stone wall, and mounted with cannon.

Glas's Historical Account of the Canary Islands.

Santa Cruz is a large town, containing several churches and convents, an hospital, and the best constructed private buildings of any in the Canary islands. It contains about 7000 inhabitants; it is not fortified on the land side, and all the country near it is dry, stony, and barren.

About four leagues to the south of Santa Cruz, close to the sea, there is a cave, with a church called the *chapel of our Lady of Candelaria*, in which is an image of the Virgin Mary, that is held in as much reverence here as that of Diana was at Ephesus. This chapel is endowed with so many ornaments that it is the richest place in all the seven islands. At a certain season of the year almost all the inhabitants go thither on pilgrimage, and innumerable and incredible stories are related and universally believed concerning this image.

About four miles inland from Santa Cruz stands the city of St Chrystobal de la Laguna, which is the metropolis of the island, and contains two parish churches and five convents, but has no trade, being inhabited principally by the gentry of the island. It contains, according to Humboldt, about 9000 inhabitants, and stands in a plain 2200 feet above the sea, in which however wheat is cultivated, There are many other towns in the island which contain a great number of people, but none are more than three leagues from the sea.

All the fertile ground within a league of the sea is covered with vines; that of the next league is sown with corn, the third is adorned with woods, and above the woods are the clouds, for the island gradually ascends from the sea, rising on all sides till it terminates in the peak, which is the centre.

On the south-east of the island inland from *Candelaria* is a town called *Guimar*, where there are some families which know themselves to be the genuine unmixed offspring of the original natives; but they know nothing of the manners of their ancestors, nor have they preserved any remains of their language. They are fairer than the Spaniards of Andalusia.

Teneriff.

Teneriff contains about 96,000 persons, supposed to be equal to the number of inhabitants of all the rest of the seven islands put together. The peasants in general are wretchedly clothed; when they do appear better, they are habited in the Spanish fashion. The men, in a genteeler line, dress very gayly, and are seldom seen without long swords. It is remarked, that few of them walk with dignity and ease; which may be attributed to the long cloaks they usually wear. The women wear veils; those worn by the lower ranks are of black stuff, those of the higher of black silk; and such among the latter as have any claim to beauty are far from being over careful in concealing their faces by them. The young ladies wear their fine long black hair plaited, and fastened with a comb or a ribband on the top of the head.

White's Voyage to New South Wales, p. 13.

The common people, and in this they resemble the inhabitants of most of the islands in the Pacific ocean lately discovered, have in them a strong tendency to thieving; they are besides lazy, and the most importunate beggars in the world. "I observed likewise (says Mr White) that the itch was so common among them, and had attained such a degree of virulence, that one would almost be led to believe it was epidemic there. Some of the women are so abandoned and shameless, that it would be doing an injustice to the prostitutes met with in the streets of London to say they are like them. The females of every degree are said to be of an amorous constitution, and addicted to intrigue; for which no houses could be better adapted than those in Teneriff.

"The manufactures carried on here are very few, and the product of them little more than sufficient for their own consumption. They consist of taffeties, gauze, coarse linens, blankets, a little silk, and curious garters. The principal dependence of the inhabitants is on their wine (their staple commodity), oil, corn, and every kind of stock for shipping. With these the island abounds; and, in their season, produces not only the tropical fruits, but the vegetable productions of the European gardens, in the greatest plenty."

The height of the peak of Teneriff has been variously estimated and calculated by different travellers and geographers. Dr Halley allows but two miles and a quarter from the level of the sea to the summit of the sugar-loaf, whilst the Spanish account of the Canary islands, translated by Mr Glas in 1763, makes it no less than five miles. Borda, however, found its height by trigonometrical measurement to be 1905 toises, or 12,181 feet. Humboldt has described the different zones characterised by certain vegetables on the sides of this mountain. At the bottom lies a plain 3320 feet above the sea, covered chiefly with arborescent heaths, in which there is a spring whose temperature is 60° Fahrenheit. Above this is the region of arborescent ferns, which is succeeded by one of junipers and pines. Next to this, at the height of 9100 feet, is a sandy plain, characterised by the *spartium nubigenum*, a species of broom. All above this the surface is nearly covered with masses of obsidian and pumice; and a little higher, traces of vegetation

Rye's Excursion to the Peak of Teneriff.

getation almost entirely disappear. Near the summit, and before sunrise, the travellers observed a singular phenomenon; luminous points floating and moving in the air, which proved to be the images of several stars, magnified by vapours. Humboldt saw the sun rise from a place near the summit, and found that the upper limb of that luminary was visible 12 minutes 55 seconds sooner than it should be in the plain by calculation. The crater is surrounded by a parapet of compact lava, and is of an elliptical form, 300 feet long by 200 broad. At the bottom the heat was perceptible only at a few crevices, from which the aqueous vapours issued with a buzzing noise. When thrust into these the thermometer rose to 122 or 135 of Fahrenheit. The vapours consist of pure water. The depth of the crater is about 110 feet. The temperature at the summit was 37° in the middle of June. The air was extremely clear, the sky of the deepest blue, and prospect most magnificent.

TENESMUS, in *Medicine*, is a continual desire of going to stool, but without any stool being ready to be voided. See MEDICINE, N° 111.

TENIERS, DAVID, the Elder, a Flemish painter, born at Antwerp in 1582. He received the first rudiments of his art from the famous Rubens, who highly esteemed him for his promising genius, and with great satisfaction examined and commended his designs. From the school of that celebrated painter Teniers went to finish his studies at Rome. He attached himself to Adam Elsheimer for six years; and from the instructions of two such incomparable masters, he formed to himself a peculiar style, which his son cultivated so happily afterward as to bring it to the utmost perfection. His pictures were small; and his subjects usually shops, elaboratories, humorous conversations, and rural festivities. The demand for his pieces was universal; and even his master Rubens thought them an ornament to his cabinet. He died at Antwerp in 1640.

TENIERS, *David*, the Younger, also an admirable painter, was the son of the former, and was born at Antwerp in 1610. He obtained the name of *Ape of Painting*, from his imitating the manner of different painters with such exactness as to deceive even the nicest judges. He improved greatly under his father, and obtained such reputation as introduced him to the favour of the great. The archduke Leopold William made him gentleman of his bedchamber; and all the pictures of his gallery were copied by Teniers, and engraved by his direction. The king of Spain and Don Juan of Austria set so high a value on his pictures, that they built a gallery on purpose for them. William prince of Orange honoured him with his friendship; and Rubens not only esteemed his works, but assisted him with his advice. His principal talent lay in landscapes, adorned with small figures. He also painted men drinking and smoking, chemists elaboratories, country fairs, and the like. His small figures are superior to his large ones. He died in 1694.

The works of the father and son are thus distinguished: The latter discover a finer touch and fresher pencil, greater variety of attitudes, and a better disposition of the figures. The father retained something of the tone of Italy in his colouring, which was stronger than the son's; besides, the son used to put at the bottom of his pictures, David Teniers, junior.

Abraham, another son of David the Elder, was equal, if not superior, to his father and brother in the expression of his characters, and his understanding the *claro obscuro;* though he was inferior in the sprightliness of his touch, and the lightness of his pencil.

TENISON, DR THOMAS, archbishop of Canterbury, was born at Cottenham in Cambridgeshire in 1636; and studied at Corpus Christi college in Cambridge. In his youth, while the fanatical government lasted, he applied himself to physic; but afterward went into orders, and was some time minister of St Andrew's church, Cambridge; where he attended the sick during the plague in 1665, which his parishioners acknowledged by the present of a piece of plate. He showed himself very active against the growth of Popery, by his writings both in King Charles's and in King James's reigns: in 1680 he was presented to the vicarage of St Martin's in the Fields, London, to which parish he made several donations; and among others, endowed a free school, and built a handsome library, which he furnished with useful books. King William and Queen Mary, in 1689, presented him to the archdeaconry of London; in 1691, he was nominated to the see of Lincoln, and in 1694 he succeeded Dr Tillotson as archbishop of Canterbury. He performed all the duties of a good primate for 20 years, and died in 1715.

TENNIS, a play at which a ball is driven by a racket.

Hoyle's Games improved by Beaufort.

As many persons would become players at tennis, provided they could easily understand the rudiments of the game, so as to form some judgment of the players, or at least to know who wins and who loses, we have here attempted to give so plain a description of it, that no one can be at a loss, if ever he should bett or play. As to the executive part, it requires great practice to make a good player, so that nothing can be done without it; all we presume to do is to give an insight into the game, whereby a person may not seem a total stranger to it when he happens to be in a tennis court.

The game of tennis is played in most capital cities in Europe, particularly in France, from whence we may venture to derive its origin. It is esteemed with many to be one of the most ancient games in Christendom, and long before King Charles I.'s time it was played in England.

This game is as intricate as any game whatever; a person who is totally ignorant of it may look on for a month together, without being able to make out how the game is decided. Therefore we shall begin by describing the court in which it is played.

The size of a tennis court is generally about 96 or 97 feet by 33 or 34, there being no exact dimension ascribed to its proportion, a foot more or less in length or width being of no consequence. A line or net hangs exactly across the middle, over which the ball must be struck, either with a racket or board to make the stroke good. Upon the entrance of a tennis-court, there is a long gallery which goes to the dedans, that is, a kind of front gallery, where spectators usually stand, into which, whenever a ball is struck, it tells for a certain stroke. This long gallery is divided into different compartiments or galleries, each of which has its particular name, as follows; from the line towards the dedans are the *first gallery*, *door*, *second gallery*, and the *last gallery*, which is called the *service side*. From the dedans to the last gallery

Tennis.

gallery are the figures 1, 2, 3, 4, 5, 6, at a yard distance each, by which the chaces are marked, and is one of the most essential parts of the game, as will appear in the following description.

On the other side of the line are also the *first gallery*, *door*, *second gallery*, and *last gallery;* which is called the *hazard-side*. Every ball struck into the last gallery on this side reckons for a certain stroke the same as the dedans. Between the second and this last gallery are the figures 1, 2, to mark the chaces on the hazard-side. Over this long gallery, or these compartiments, is a covering, called the pent-house, on which they play the ball from the service-side, in order to begin a set of tennis, from which it is called a *service*. When they miss putting the ball (so as to rebound from the pent-house) over a certain line on the service side, it is deemed a fault, two of which are reckoned for a stroke. If the ball rolls round the pent-house, on the opposite side of the court, so as to fall beyond a certain line described for that purpose, it is called *passe*, reckons for nothing on either side, and the player must serve again.

On the right-hand side of the court from the dedans is what they call the *tambour*, a part of the wall which projects, and is so contrived in order to make a variety in the stroke, and render it more difficult to be returned by the adversary; for when a ball strikes the *tambour*, it varies its direction, and requires some extraordinary judgment to return it over the line. The last thing on the right hand side is called the *grill*, wherein if the ball is struck, it is also 15, or a certain stroke.

The game of tennis is played by what they call *sets;* a set of tennis consists of six games: but if they play what is called an advantage-set, two above five games must be won on one side or the other successively, in order to decide; or, if it comes to six games all, two games must still be won on one side to conelude the set; so that an advantage-set may last a considerable time; for which kind of sets the court is paid more than for any other.

We must now describe the use of the chaces, and by what means these chaces decide or interfere so much in the game. When the player gives his service at the beginning of a set, his adversary is supposed to return the ball; and wherever it falls after the first rebound untouched, the chace is called accordingly; for example, if the ball falls at the figure 1, the chace is called at a yard, that is to say, at a yard from the dedans: this chace remains till a second service is given; and if the player on the service side lets the ball go after his adversary returns it, and if the ball falls on or between any of these figures or chaces, they must change sides, there being two chaces; and he who then will be on the hazard side, must play to win the first chace; which if he wins by striking the ball so as to fall, after its first rebound, nearer to the dedans than the figure 1, without his adversary's being able to return it from its first hop, he wins a stroke, and then proceeds in like manner to win the second chace, wherever it should happen to be. If a ball falls on the line with the first gallery door, second gallery, or last gallery, the chace is likewise called at such or such a place, naming the gallery, door, &c. When it is just put over the line, it is called a chace at the line. If the player on the service-side returns a ball with such force as to strike the wall on the hazard-side so as to rebound, after the first hop over the line, it is also called a chace at the line.

The chaces on the hazard-side proceed from the ball being returned either too hard or not quite hard enough; so that the ball after its first rebound falls on this side of the blue line, or line which describes the hazard-side chaces; in which case it is a chace at 1, 2, &c. provided there is no chace depending. When they change sides, the player, in order to win this chace, must put the ball over the line anywhere, so that his adversary does not return it. When there is no chace on the hazard-side, all balls put over the line from the service-side, without being returned, reckon for a stroke.

As the game depends chiefly upon the marking, it will be necessary to explain it, and to recommend those who play at tennis to have a good and unbiassed marker, for on him the whole set may depend: he can mark in favour of the one and against the other in such a manner, as will render it two to one at starting, though even players. Instead of which the marker should be very attentive to the chaces, and not be anyway partial to either of the players.

This game is marked in a very singular manner, which makes it at first somewhat difficult to understand. The first stroke is called 15, the second 30, the third 40, and the fourth game, unless the players get four strokes each; in that case, instead of calling it 40 all, it is called *deuce;* after which, as soon as any stroke is got, it is called *advantage;* and in case the strokes become equal again, *deuce* again, till one or the other gets two strokes following, which win the game; and as the games are won, so they are marked and called; as one game love, two games to one, &c. towards the set, of which so many of these games it consists.

Although but one ball at a time is played with, a number of balls are made use of at this game to avoid trouble, and are handed to the players in baskets for that purpose; by which means they can play as long as they please, without ever having occasion to stoop for a ball.

There are various methods of giving odds at tennis, in order to make a match equal; and that they may be understood, we shall give the following list of them, with their meanings, so that any person may form a judgement of the advantage received or given.

The lowest odds that can be given, excepting the choice of the sides, is what they call a *bisque*, that is, a stroke to be taken or scored whenever the player, who receives the advantage, thinks proper: for instance, suppose a critical game of the set to be forty thirty, by taking the *bisque*, he who is forty becomes game, and so in respect of two *bisques*, &c.

The next greater odds are *fifteen*, that is, a certain stroke given at the beginning of each game.

After these, *half thirty*, that is, fifteen one game, and thirty the next. Then follow the whole *thirty*, *forty*, &c.

There are also the following kind of odds which are given, viz.

Round services; those are services given round the pent-house, so as to render it easy for the *striker out* (the player who is on the hazard side) to return the ball.

Half court, that is, being obliged or confined to play into the adversary's half-court; sometimes it is played straightwise, and at other times across; both which are great advantages given by him so confined, but the strait half-court is the greatest.

Touch no-wall, that is, being obliged to play within the compass of the walls, or sides of the court. This is

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a considerable advantage to him who receives it; as all the balls must be played gently, and consequently they are much easier to take than those which are played hard, or according to the usual method of play.

Barring the hazards, that is, barring the dedans, tambour, grill, or the last gallery on the hazard-side, or any particular one or more of them.

These are the common kind of odds or advantages given; but there are many others, which are according to what is agreed by the players: such as playing with *board* against *racket*, *cricket-bat* against *racket*, &c.

The game of tennis is also played by four persons, two partners on each side. In this case, they are generally confined to their particular quarters, and one of each side appointed to serve and strike out; in every other respect, the game is played in the same manner as when two only play.

Any thing more to be said upon this subject would be needless, as nothing can be recommended after reading this short account of tennis, but practice and attention, without which no one can become a proficient at the game.

TENOR, or TENOUR, the purport or content of a writing or instrument in law, &c.

TENOR, in *Music*, the first mean, or middle part, or that which is the ordinary pitch of the voice, when neither raised to a treble nor lowered to a bass.

TENNESSEE, one of the United States of North America. It is bounded on the north by Kentucky and Virginia; south by the states of Mississippi and Georgia, and the territory of Alibama; east by North Carolina; and west by the river Mississippi. The parallel of 35° and 36° 30′ forms the southern and northern boundaries. The area is about 40,000 square English miles. In point of soil and climate this is one of the most favoured states in the Union. In the eastern parts the country is mountainous, in the western it is finely diversified with low hills; and every where it is well watered, covered with excellent wood, and affording when broken up most productive crops. Wheat, barley, rye, maize, flax, hemp, tobacco, indigo, rice, and cotton, thrive luxuriantly. Lands of the first and second quality are too rich for wheat till they have been reduced by other crops. On Cumberland river the common produce of Indian corn is 60 to 70 bushels an acre; that of cotton is usually 800 pounds an acre. Vegetation is six or seven weeks earlier than in the eastern states. The rivers are scarcely ever frozen, and the snow seldom continues more than ten or twelve days. In some of the low grounds bilious fever prevails; but in general this state is one of the healthiest in North America.

The principal rivers are the Tennessee with its branches, and the Cumberland. The former is navigable for boats 500 miles, with one interruption, and by its branches a considerable way farther. The latter is navigable for boats of 20 tons to Nashville, 200 miles up, and for small craft 150 miles farther.

Iron ores are abundant in this state, and lead ore is also found. Limestone is common; gypsum and slate exist in some places. Nitre is found in prodigious quantities in vast natural caves of a wonderful extent, some of which have large streams running through them. The natural forests furnish wood of all kinds and of excellent quality. The wild animals consist of deer, bears, panthers, wolves, wild cats, racoons, foxes, beavers, &c. The animals of prey are seldom seen near cultivated tracts.

This state was first settled in 1774, and was admitted into the union in 1796. Its population in 1791 was only 35,691; but in 1810 had increased to 261,727, of whom 44,535 were slaves. The inhabitants are good horsemen, expert in the use of the rifle, active and enterprising, but addicted to gaming and fighting. The legislature consists of a senate and house of representatives, elected by all the free citizens of 21 years of age, who have resided six months in the state. The executive power is vested in a governor elected for two years. The judges are appointed by the legislature during good behaviour. The religious denominations are Presbyterians, Baptists, Roman Catholics, Methodists, and Episcopalians. There are four colleges in the state, none of which have yet acquired much celebrity. The value of lands and houses in this state, as ascertained by the assessment, in 1799 was 6,134,108 dollars; and in 1814 it was 24,233,750, exclusive of slaves. The value of the manufactures of this state, which are chiefly domestic, was found to be 3,611,029 in 1810. Tennessee being entirely an inland state, its commerce is carried on chiefly through New Orleans, and hence the value of its exports does not appear. They consist principally of saltpetre, tobacco, corn, hogs, and cattle. The imports are dry goods, groceries, &c. Maple sugar is generally made by the farmers themselves. A single tree on an average yields from 15 to 25 gallons of sap, from which four or five pounds of sugar is extracted. The quantity made in the state in 1810 amounted to 162,340 pounds.

TENSE, in *Grammar*, an inflection of verbs, whereby they are made to signify or distinguish the circumstance of time in what they affirm. See GRAMMAR.

TENT, in *War*, a pavilion or portable house. Tents are made of canvas, for officers and soldiers to lie under when in the field. The size of the officers tents is not fixed; some regiments have them of one size and some of another; a captain's tent and marquee is generally $10\frac{1}{2}$ feet broad, 14 deep, and 8 high: the subalterns are a foot less; the major's and lieutenant-colonel's a foot larger; and the colonel's two feet larger. The subalterns of foot lie two in a tent, and those of horse but one. The tents of private men are $6\frac{1}{2}$ feet square, and 5 feet high, and hold five soldiers each. The tents for horse are 7 feet broad and 9 feet deep: they hold likewise five men and their horse accoutrements.—The word is formed from the Latin *tentorium*, of *tendo*, "I stretch," because tents are usually made of canvas stretched out, and sustained by poles, with cords and pegs.

TENT, in *Surgery*, a roll of lint made into the shape of a nail with a broad flat head, chiefly used in deep wounds and ulcers. They are of service, not only in conveying medicines to the most intimate recesses and sinuses of the wound, but to prevent the lips of the wound from uniting before it is healed from the bottom; and by their assistance grumous blood, sordes, &c. are readily evacuated.

TENTER, TRIER, or *Prover*, a machine used in the cloth manufactory, to stretch out the pieces of cloth, stuff, &c. or only to make them even and set them square.

It is usually about $4\frac{1}{2}$ feet high, and for length exceeds that of the longest piece of cloth. It consists of several long square pieces of wood, placed like those which form the barriers of a manege; so, however, as that

Tenter ‖ Tenths.

that the lower cross pieces of wood may be raised or lowered as is found requisite, to be fixed at any height by means of pins. Along the cross pieces, both the upper and the under one, are hooked nails, called *tenter-hooks*, driven in from space to space.

To put a piece of cloth on the TENTER. While the piece is yet quite wet, one end is fastened to one of the ends of the tenter; then it is pulled by force of arms towards the other end, to bring it to the length required: that other end being fastened, the upper list is hooked on to the upper cross-piece, and the lowest list to the lowest cross piece, which is afterwards lowered by force till the piece have its desired breadth. Being thus well stretched, both as to length and breadth, they brush it with a stiff hair brush, and thus let it dry. Then they take it off; and, till they wet it again, it will retain the length and breadth the tenter gave it.

TENTHREDO, the SAW-FLY; a genus of insects belonging to the order of *hymenoptera*. See ENTOMOLOGY *Index*.

TENTHS, and *First Fruits of Spiritual Preferments*, a branch of the king's revenue. See REVENUE.

These were originally a part of the Papal usurpations over the clergy of this kingdom; first introduced by Pandulph the pope's legate, during the reigns of King John and Henry III. in the see of Norwich; and afterwards attempted to be made universal by the popes Clement V. and John XXII. about the beginning of the 14th century. The first fruits, *primitiæ* or *annates*, were the first year's whole profits of the spiritual preferment, according to a rate or *valor* made under the direction of Pope Innocent IV. by Walter bishop of Norwich in 38 Hen. III. and afterwards advanced in value by commission from Pope Nicholas III. A. D. 1202, 20 Edw. I.; which valuation of Pope Nicholas is still preserved in the exchequer. The tenths, or *decimæ*, were the tenth part of the annual profit of each living by the same valuation; which was also claimed by the holy see, under no better pretence than a strange misapplication of that precept of the Levitical law, which directs, that the Levites "should offer the tenth part of their tithes as a heave offering to the Lord, and give it to Aaron the highpriest." But this claim of the pope met with vigorous resistance from the English parliament; and a variety of acts were passed to prevent and restrain it, particularly the statute 6 Hen. IV. c. 1. which calls it a *horrible mischief and damnable custom*. But the Popish clergy, blindly devoted to the will of a foreign master, still kept it on foot; sometimes more secretly, sometimes more openly and avowedly: so that in the reign of Henry VIII. it was computed, that in the compass of 50 years 800,000 ducats had been sent to Rome for first fruits only. And as the clergy expressed this willingness to contribute so much of their income to the head of the church, it was thought proper (when in the same reign the papal power was abolished, and the king was declared the head of the church of England) to annex this revenue to the crown; which was done by statute 26 Hen. VIII. c. 3. (confirmed by statute 1 Eliz. c. 4.); and a new *valor beneficiorum* was then made, by which the clergy are at present rated.

Blackst. Comment. vol. i.

By these last-mentioned statutes all vicarages under ten pounds a-year, and all rectories under ten marks, are discharged from the payment of first fruits: and if, in such livings as continue chargeable with this payment, the incumbent lives but half a year, he shall pay only one quarter of his first fruits; if but one whole year, then half of them; if a year and a half, three quarters; and if two years, then the whole, and not otherwise. Likewise by the statute 27 Hen. VIII. c. 8. no tenths are to be paid for the first year, for then the first fruits are due: and by other statutes of Queen Anne, in the fifth and sixth years of her reign, if a benefice be under 50l. per annum clear yearly value, it shall be discharged of the payment of first fruits and tenths.

Tenths, Tenure.

Thus the richer clergy being, by the criminal bigotry of their Popish predecessors, subjected at first to a foreign exaction, were afterwards, when that yoke was shaken off, liable to a like misapplication of their revenues through the rapacious disposition of the then reigning monarch; till at length the piety of Queen Anne restored to the church what had been thus indirectly taken from it. This she did, not by remitting the tenths and first fruits entirely; but, in a spirit of the truest equity, by applying these superfluities of the larger benefices to make up the deficiencies of the smaller. And to this end she granted her royal charter, which was confirmed by the statute 2 Ann. c. 11. whereby all the revenue of first fruits and tenths is vested in trustees for ever, to form a perpetual fund for the augmentation of poor livings. This is usually called *Queen Anne's bounty;* which has been still farther regulated by subsequent statutes.

TENURE, in *Law*, signifies the manner whereby lands or tenements are held, or the service that the tenant owes to his lord.

Of this kingdom almost all the real property is by the policy of our laws supposed to be granted by, dependent upon, and holden of, some superior lord, by and in consideration of certain services to be rendered to the lord by the tenant or possessor of this property. The thing holden is therefore styled a *tenement*, the possessors thereof *tenants*, and the manner of their possession a *tenure*. Thus all the lands in the kingdom are supposed to be holden, mediately or immediately, of the king; who is styled the *lord paramount*, or above all. Such tenants as held under the king immediately, when they granted out portions of the lands to inferior persons, became also lords with respect to those inferior persons, as they were still tenants with respect to the king; and thus partaking of a middle nature, were called *mesne* or *middle lords*. So that if the king granted a manor to A, and he granted a portion of the land to B, now B was said to hold of A, and A of the king; or, in other words, B held his lands immediately of A, but mediately of the king. The king therefore was styled *lord paramount:* A was both tenant and lord, or was a mesne lord; and B was called *tenant paravail* or the *lowest tenant*, being he who was supposed to make avail or profit of the land. In this manner are all the lands of the kingdom holden which are in the hands of subjects: for, according to Sir Edward Coke, in the law of England we have not properly *allodium*, which is the name by which the feudists abroad distinguish such estates of the subject as are not holden of any superior. So that at the first glance we may observe, that our lands are either plainly feuds, or partake very strongly of the foedal nature.

Blackst. Comment. vol. ii.

All tenures being thus derived, or supposed to be derived, from the king, those that held immediately under him, in right of his crown and dignity, were called his *tenants in capite*, or *in chief;* which was the most honourable species of tenure, but at the same time subjected the tenants to greater and more burdensome services

services than inferior tenures did. And this distinction ran through all the different sorts of tenure.

There seem to have subsisted among our ancestors four principal species of lay-tenures, to which all other may be reduced: the grand criteria of which were the natures of the several services or renders that were due to the lords from their tenants. The services, in respect of their quality, were either *free* or *base* services: in respect of their quantity and the time of exacting them, were either *certain* or *uncertain*. Free services were such as were not unbecoming the character of a soldier or a freeman to perform; as to serve under his lord in the wars, to pay a sum of money, and the like. Base services were such as were fit only for peasants or persons of a servile rank; as to plough the lord's land, to make his hedges, to carry out his dung, or other mean employments. The certain services, whether free or base, were such as were stinted in quantity, and could not be exceeded on any pretence; as, to pay a stated annual-rent, or to plough such a field for three days. The uncertain depended upon unknown contingencies; as, to do military service in person, or pay an assessment in lieu of it when called upon; or to wind a horn upon the appearance of invaders; which are free services; or to do whatever the lord should command; which is a base or villein service.

From the various combinations of these services have arisen the four kinds of lay-tenure which subsisted in England till the middle of the last century; and three of which subsist to this day. Of these Bracton (who wrote under Henry III.) seems to give the clearest and most compendious account of any author ancient or modern; of which the following is the outline or abstract: "Tenements are of two kinds, *frank-tenement*, and *villenage*. And of frank-tenements, some are held freely in consideration of homage and knight-service; others in free-socage, with the service of fealty only. And again, of villenages, some are *pure*, and others *privileged*. He that holds in pure villenage shall do whatsoever is commanded him, and always be bound to an uncertain service. The other kind of villenage is called *villein-socage;* and these villein-socmen do villein services, but such as are certain and determined." Of which the sense seems to be as follows; first, where the service was free, but uncertain, as military service with homage, that tenure was called the *tenure in chivalry*, *per servitium militare*, or by knight-service. Secondly, where the service was not only free, but also certain, as by fealty only, by rent and fealty, &c. that tenure was called *liberum socagium*, or *free socage*. These were the only free holdings or tenements; the others were villenous or servile: as, thirdly, where the service was base in its nature, and uncertain as to time and quantity, the tenure was *purum villenagium*, absolute or pure villenage. Lastly, where the service was base in its nature, but reduced to a certainty, this was still villenage, but distinguished from the other by the name of *privileged villenage*, *villenagium privilegiatum;* or it might be still called *socage* (from the certainty of its services), but degraded by their baseness into the inferior title of *villanum socagium*, villein-socage.

1. The military tenure, or that by knight-service, was done away by stat. 12 Car. II. For an account of this species of tenure see *Feodal System*, and *Knight-Service;* and for its incidents, see Relief, Primer-seisin, Wardship, Marriage, Fines, and Escheat.

2. The second species of tenure or free-socage, not only subsists to this day, but has in a manner absorbed and swallowed up (since the statute of Charles the Second) almost every other species of tenure. Se Socage.

The other grand division of tenure, mentioned by Bracton, is that of villenage, as contradistinguished from *liberum tenementum*, or frank-tenure. And this (we may remember) he subdivides into two classes, pure and privileged villenage: from whence have arisen two other species of our modern tenures.

3. From the tenure of pure villenage have sprung our present copyhold tenures, or tenure by copy of court-roll at the will of the lord; in order to obtain a clear idea of which, it will be previously necessary to consult the articles Manor and Villenage.

As a farther consequence of what has been there explained, we may collect these two main principles, which are held to be the supporters of a copyhold-tenure, and without which it cannot exist: 1. That the lands be parcel of and situate within that manor under which it is held. 2. That they have been demised, or demisable, by copy of court-roll immemorially. For immemorial custom is the life of all tenures by copy; so that no new copyhold can, strictly speaking, be granted at this day.

In some manors, where the custom hath been to permit the heir to succeed the ancestor in his tenure, the estates are styled *copyholds of inheritance;* in others, where the lords have been more vigilant to maintain their rights, they remain copyholds for life only; for the custom of the manor has in both cases so far superseded the will of the lord, that, provided the services be performed or stipulated for by fealty, he cannot in the first instance refuse to admit the heir of his tenant upon his death; nor, in the second, can he remove his present tenant so long as he lives, though he holds nominally by the precarious tenure of his lord's will.

The fruits and appendages of a copyhold-tenure, that it hath in common with free tenures, are fealty, services (as well in rents as otherwise), reliefs, and escheats. The two latter belong only to copyholds of inheritance; the former to those for life also. But, besides these, copyholds have also heriots, wardship, and fines. Heriots, which are agreed to be a Danish custom, are a render of the best beast or other good (as the custom may be) to the lord on the death of the tenant. This is plainly a relic of villein tenure; there being originally less hardship in it, when all the goods and chattels belonged to the lord, and he might have seized them even in the villein's lifetime. These are incident to both species of copyhold; but wardship and fines to those of inheritance only. Wardship, in copyhold-estates, partakes both of that in chivalry and that in socage. Like that in chivalry, the lord is the legal guardian, who usually assigns some relation of the infant tenant to act in his stead: and he, like guardian in socage, is accountable to his ward for the profits. Of fines, some are in the nature of primer-seisms, due on the death of each tenant, others are mere fines for alienations of the lands; in some manors, only one of those sorts can be demanded, in some both, and in others neither. They are sometimes arbitrary and at the will of the lord, sometimes fixed by custom; but, even when arbitrary, the courts of law, in favour of the liberty of copyholders, have tied them down to be reasonable in their extent; otherwise they might amount to disherison of of the estate. No fine therefore is allowed to be taken upon descents and alienations (unless in particular circumstances) of more than two years improved values of the estate. From this instance we may judge of the favourable disposition that the law of England (which is a law of liberty) hath always shown to this species of tenants, by removing, as far as possible, every real badge of slavery from them, however some nominal ones may continue. It suffered custom very early to get the better of the express terms upon which they held their lands; by declaring that the will of the lord was to be interpreted by the custom of the manor; and, where no custom has been suffered to grow up to the prejudice of the lord, as in this case of arbitrary fines, the law itself interposes in an equitable method, and will not suffer the lord to extend his power so far as to disinherit the tenant.

4. There is yet a fourth species of tenure, described by Bracton, under the name sometimes of *privileged villenage*, and sometimes of *villein socage*. See *Privileged* VILLENAGE.

Having in the present article, and those referred to, taken a compendious view of the principal and fundamental points of the doctrine of tenures, both ancient and modern, we cannot but remark the mutual connection and dependence that all of them have upon each other. And upon the whole it appears, that, whatever changes and alterations these tenures have in process of time undergone, from the Saxon era to the 12 Car. II. all lay-tenures are now in effect reduced to two species; free tenure in common socage, and base tenure by copy of court-roll. But there is still behind one other species of tenure, reserved by the statute of Charles II. which is of a spiritual nature, and called the tenure in *FRANK-Almoign;* see that article.

A particular account of the ancient tenures would to many persons be highly amusing. We can only select a few of the most singular, referring the curious reader for more information to Anderson's Origin of Commerce, Henry's History of Britain, and Blount's *Fragmenta Antiquitates.*

In the 19th of Henry III. Walter Gately held the manor of Westcourt, in Bedington in Surry, yielding yearly to the king one cross-bow, *balistam*, value twelve pence.

Anno tertio Edw. I. Osbert de Lonchamp, knight, held his lands of Ovenhelle, in Kent, for personally guarding the king forty days into Wales at his own expence, with one horse of five shillings value, one sack worth sixpence, and one broch for that sack. N. B. All personal services, or attendances on our kings in those times, were limited to forty days, at their own expence.

The like the same year of Laurence de Broke, who for his hamlet of Renham in Middlesex, found the king one soldier, a horse worth five shillings, a sack worth fivepence, and a broch worth twopence (this broch was a kind of cup, jug, pot, or bason), for forty days, at his own expence, wherever his army shall be within the four seas. This was settled (says Mr Blount) at the Stone Cross, which stood near the May-pole in the Strand, London, where the judges-itinerant used in old times to sit.

Robert Maunsel's tenure of lands in Peverel paid the same service, and the horse, sack, and broch of the same prices.

13mo Edw. I. Henry de Averning's tenure of the manor of Morton in Essex, was to find a man, a horse worth ten shillings, four horse-shoes, a leather sack, and an iron broch.

The year following three persons held thirty acres of land in Carleton in Norfolk, by the service of bringing the king, whenever he shall be in England, twenty-four pasties of fresh herrings at their first coming in.

Another held his manor in Norfolk of that king, by annually supplying him at his exchequer with two vessels, called *mues*, of wine made of pearmains. "Here (says our author) it is worth observing, that in King Edward the First's time pearmain cyder was called *wine.*" This therefore seems to account for the mention of vineyards in old times in Kent, Sussex, and other parts of England, which has so often puzzled many people to elucidate.

Another person, in the 21st of the said king, held thirty acres of land, valued at ten shillings yearly in the exchequer, or four-pence per acre, in Cambridgeshire, for furnishing a truss of hay for the king's necessary-house or privy, whenever he shall come into that county.

Another, in the 34th of that king, held a manor in Kent for providing a man to lead three greyhounds when the king shall go into Gascony, so long as a pair of shoes of fourpence should last.

And that we may not again recur to these old tenures, we shall further add, from the same author, that in the first year of King Edward II. Peter Spileman made fine to the king for his lands by serjeanty, to find one to serve as a soldier for forty days in England, with a coat of mail; also to find straw for the king's bed, and hay for his horse.

This article of straw for the king's bed we did not so much wonder at, when we found it in an article in William the Conqueror's time; but it is somewhat more remarkable so late as the days of King Edward II.

Several others, we find, held their lands of the crown in those times by very different tenures. One, by paying two white capons annually; another, by carrying the king's standard whenever he happens to be in the county of Sussex; another, by carrying a rod or batoon before the king on certain occasions; another, by serving the office of chamberlain of the exchequer, a very good place at present; another, by building and upholding a bridge; another, by being marechal (*meretricum*), i. e. as Mr Blount translates it, of the laundresses in the king's army; another, by acting as a serjeant at arms for the king's army whilst in England; one supplies a servant for the king's larder; another, for his wardrobe; others, to find servants for this or that forest; another, a hawk; one presents the king a pair of scarlet hose annually; others are bound to supply soldiers with armour for certain days, for the keeping this or that castle; one, viz. for the manor of Elston in Nottinghamshire, pays yearly rent of one pound weight of cummin seed, two pair of gloves, and a steel needle; another, is to repair the iron-work of the king's ploughs; Ela countess of Warwick, in the 13th year of King Edward I. held the manor of Hokenorton in Oxfordshire, in the barony of D'Oyly, by the serjeanty of of carving at the king's table on his birth-day, and she to have the knife the king then uses at table.

TEOS, one of the twelve Ionian cities, was situated on the south side of the Ionian peninsula, and distinguished by being the place where the poet Anacreon and the historian Hecatœus were born.

TERAPHIM, or THERAPHIM, a word in the Hebrew language, which has exercised much the ingenuity of the critics. It occurs 13 or 14 times in the Old Testament, and is commonly interpreted *idols*. We will not trouble our readers with the numerous conjectures which have been formed respecting the meaning of this word. The only way to determine it, if it be at all possible, would be to examine and compare all the passages in which it occurs, and to consult the ancient translations. Conjectures are useless; every man may make a new one, which will have just as good a title to belief as those which have been already proposed.

TERCERY, or TERCERA, one of the largest islands of the Azores, or Western islands, lying in the Atlantic ocean. It is about 40 miles in circumference; and surrounded with craggy rocks, which render it almost inaccessible. The soil is fertile, abounding in corn, wine, and fruits; and they have plenty of cattle to supply the ships which call there. Their principal trade is wood. The inhabitants are lively, addicted to gallantry, and are said to be extremely revengeful. It is subject to Portugal; and Angra is the capital town. W. Long. 27. 1. N. Lat. 28. 45.

TEREBELLA, the PIERCER, a genus of insects belonging to the class of vermes, and order of mollusca. See HELMINTHOLOGY *Index*.

TEREBINTHUS. See PISTACIA, BOTANY *Index*.

TEREDO, a genus of vermes belonging to the order of testacea. See CONCHOLOGY *Index*.

TERENCE, or PUBLIUS TERENTIUS AFER, a celebrated comic poet of ancient Rome, was born at Carthage in Africa. He was slave to Terentius Lucanus the senator; who gave him his liberty on account of his wit, his good mien, and great abilities. Terence, on his becoming a freed man, applied himself to the writing of comedies; in the execution of which he imitated Menander and the other celebrated comic poets of Greece. Cicero gives him the most pompous eulogiums, both for the purity of his language and the perspicuity and beauty of his compositions, which he considers as the rule and standard of the Latin tongue; and observes, that they were esteemed so fine and elegant, that they were thought to have been written by Scipio and Lelius, who were then the greatest personages and the most eloquent of the Roman people. Terence died while on a voyage into Greece, about the 15th year before the Christian era. There are six of his comedies extant, of which the best editions are the Elzevir one 1635, 12mo; that *cum integris notis Donati, et selectis variorum*, 1686, 8vo; Westerhovius's, in two vols 4to, 1726; and that of Bentley the same year, 4to. Madame Dacier has given a beautiful French version of this author; and a very good English translation was published in 4to, 1768, by Mr Colman.

TERM, in *Law*, is generally taken for a limitation of time or estate; as, a lease for term of life or years.

Term, however, is more particularly used for that time wherein our courts of justice are open; in opposition to which, the rest of the year is called *vacation*.

TERM, in *Grammar*, denotes some word or expression in a language.

The word *term*, *terminus*, is borrowed metaphorically, by the grammarians and philosophers, from the measurers or surveyors of lands: as a field is defined and distinguished by its *termini*, or limits, so is a thing or matter spoken of by the word or term it is denoted by.

TERM in the Arts, or *TERM of Art*, is a word, which, besides the literal and popular meaning which it has or may have in common language, bears a further and peculiar meaning in some art or science.

TERMS, the several times or seasons of the year, wherein the tribunals, or courts of judicature, are open to all who think fit to complain of wrong, or to seek their rights by due course of law, or action; and during which the courts in Westminster-hall sit and give judgement. But the high court of parliament, the chancery, and inferior courts, do not observe the terms; only the courts of king's-bench, common-pleas, and exchequer, which are the highest courts at common law. In contradistinction to these, the rest of the year is called *vacation*.

Of these terms there are four in every year, during which time matters of justice are dispatched. *Hilary-term*, which, at London, begins the 23d day of January, or if that be Sunday, the next day after; and ends the 12th of February following. *Easter-term*, which begins the Wednesday fortnight after Easter-day, and ends the Monday next after Ascension-day. *Trinity-term*, beginning the Friday next after Trinity-Sunday, and ending the Wednesday fortnight after. *Michaelmas-term*, which begins the sixth day of November, and ends the 28th of November following. Each of these terms have also their returns. These terms are supposed by Mr Selden to have been instituted by William the Conqueror; but Sir H. Spelman hath shewn, that they were gradually formed from the canonical constitutions of the church; being no other than those leisure seasons of the year which were not occupied by the great festivals or fasts, or which were not liable to the general avocations of rural business. Throughout all Christendom, in very early times, the whole year was one continual term for hearing and deciding causes. For the Christian magistrates, in order to distinguish themselves from the heathens, who were very superstitious in the observation of their *dies fasti* and *nefasti*, administered justice upon all days alike; till at length the church interposed, and exempted certain holy seasons from being profaned by the tumult of forensic litigations; as, particularly, the time of Advent and Christmas, which gave rise to the winter vacation; the time of Lent and Easter, which created that in the spring; the time of Pentecost, which produced the third; and the long vacation, between midsummer and Michaelmas, which was allowed for the hay-time and harvest. All Sundays also, and some peculiar festivals, as the days of the purification, ascension, &c. were included in the same prohibition, which was established by a canon of the church, A. D. 517, and fortified by an imperial constitution of the younger Theodosius, comprised in the Theodosian code. Afterwards, when our own legal constitution was established, the commencement and duration of our law-terms

terms were appointed, with a view to these canonical prohibitions; and it was ordered by the laws of King Edward the Confessor, that from Advent to the octave of the Epiphany, from Septuagesima to the octave of Easter, from the Ascension to the octave of Pentecost, and from three in the afternoon of all Saturdays till Monday morning, the peace of God and holy church shall be kept throughout the whole kingdom.

And so extravagant was afterwards the regard paid to these holy times, that though the author of the Mirror mentions only one vacation of considerable length, containing the months of August and September, yet Britton says, that in the reign of King Edward I. no secular plea could be held, nor any man sworn on the Evangelists, in the time of Advent, Lent, Pentecost, harvest, and vintage, the days of the great litanies, and all solemn festivals. He adds, that the bishops and prelates granted dispensations for taking assizes and juries in some of these holy seasons, upon reasonable occasions; and soon after a general dispensation was established in parliament by stat. Westm. 1. 3 Edw. I. cap. 51. that assizes of novel disseisin, *mort d'ancestor*, and darrein presentment, should be taken in Advent, Septuagesima, and Lent, as well as inquests; at the special request of the king to the bishops. The portions of time that were not included within these prohibited seasons fell naturally into a fourfold division; and from some festival, or saint's day, that immediately preceded their commencement, were denominated the terms of *St Hilary*, of *Easter*, of the *Holy Trinity*, and of *St Michael*: which terms have been since regulated and abbreviated by several acts of parliament; particularly Trinity-term by stat. 32 Hen. VIII. cap. 2. and Michaelmas-term by stat. 16 Car. I. cap. 6. and again by stat. 24 Geo. II. cap. 48.

Terms, *Oxford*. Hilary or Lent-term begins January 14th, and ends the Saturday before Palm-Sunday. Easter term begins the tenth day after Easter, and ends the Thursday before Whitsunday. Trinity-term begins the Wednesday after Trinity-Sunday, and ends after the act, or 6th of July, sooner or later, as the vice-chancellor and convocation please. Michaelmas-term begins October the 10th, and ends December the 17th.

Terms, *Cambridge*. Lent-term begins January the 14th, and ends Friday before Palm-Sunday. Easter-term begins the Wednesday after Easter-week, and ends the week before Whitsunday. Trinity-term begins the Wednesday after Trinity-Sunday, and ends the Friday after the commencement, or 2d of July. Michaelmas-term begins October the 10th, and ends December the 16th.

Terms, *Scottish*. The court of session has two terms, the winter and summer. The winter begins on 12th November, and ends 11th March, only there is a recess of three weeks at Christmas. The summer term commences 12th May, and ends 11th July. The court of exchequer has four terms: 1. Candlemas term begins 15th January, and ends 3d February; 2. Whitsuntide term begins 12th May, and ends 2d June; 3. Lammas term begins 17th June, and ends 5th July; 4. Martinmas term begins 24th November, and ends 20th December.

Terms, *Irish*. In Ireland the terms are the same as at London, except Michaelmas term, which begins October the 13th, and adjourns to November the 3d, and thence to the 6th.

TERMES, a genus of insects belonging to the order of aptera. See Entomology *Index*.

TERMINALIA, in antiquity, feasts celebrated by the Romans in honour of the god Terminus.

Terminalia, a genus of plants belonging to the class polygamia. See Botany *Index*.

TERMINI, in *Architecture*, denote a kind of statues or columns, adorned on the top with the figure of a man's, woman's, or satyr's head, as a capital; and the lower part ending in a kind of sheath or scabbard.

TERMINUS, in Pagan worship, an ancient deity among the Romans, who presided over the stones or landmarks, called *termini*, which were held so sacred, that it was accounted sacrilege to move them; and as the criminal became devoted to the gods, it was lawful for any man to kill him. The worship of this deity was instituted by Numa Pompilius, who, to render landmarks, and consequently the property of the people, sacred, erected a temple on the Tarpeian mount to Terminus.

TERN. See Sterna, Ornithology *Index*.

TERNATE, the most northerly of the Molucca or Clove islands in the East Indies. It abounds in cocoa-nuts, bananas, citrons, oranges, and other fruits peculiar to the torrid zone; but cloves are the most valuable produce. It is in the possession of the Dutch. Malaya is the capital town. E. Long. 129. 0. N. Lat. 1. 0.

TERNI, a town of Italy in the pope's territories, and in the duchy of Spoletto, with a bishop's see. It is but a small place; though there are very beautiful ruins of antiquity, it having been a very considerable Roman colony. It is situated on the top of a high mountain, and to the west of it are fields which are extremely fertile. E. Long. 12. 40. N. Lat. 42. 34.

TERNSTROMIA, a genus of plants belonging to the class polyandria. See Botany *Index*.

TERPANDER, a celebrated Greek poet and musician. The Oxford marbles tell us that he was the son of Derdeneus of Lesbos, and that he flourished in the 381st year of these records; which nearly answers to the 27th Olympiad, and 671st year B. C. The marbles inform us likewise, that he taught the *nomes*, or airs, of the lyre and flute, which he performed himself upon this last instrument, in concert with other players on the flute. Several writers tell us that he added three strings to the lyre, which before his time had but four; and in confirmation of this, Euclid and Strabo quote two verses, which they attribute to Terpander himself.

> The tetrachord's restraint we now despise,
> The seven-string'd lyre a nobler strain supplies.

Among the many signal services which Terpander is said to have done to music, none was of more importance than the notation that is ascribed to him for ascertaining and preserving melody, which before was traditional, and wholly dependent on memory. The invention, indeed, of musical characters has been attributed by Alypius and Gaudentius, two Greek writers on music, and upon their authority by Boethius, to Pythagoras, who flourished full two centuries after Terpander. But Plutarch, from Heraclides of Pontus, assures us that Terpander, the inventor of nomes for the cithara, in hexameter

hexameter verse, set them to music, as well as the verses of Homer, in order to sing them at the public games: And Clemens Alexandrinus, in telling us that this musician wrote the laws of Lycurgus in verse, and set them to music, makes use of the same expression as Plutarch; which seems clearly to imply a written melody.

After enumerating the airs which Terpander had composed and to which he had given names, Plutarch continues to speak of his other compositions; among which he describes the proems, or hymns for the cithara, in heroic verse. These were used in after-times by the rhapsodists, as prologues or introductions to the poems of Homer and other ancient writers. But Terpander rendered his name illustrious, no less by his performances upon the flute and cithara than by his compositions. This appears by the marbles already mentioned; by a passage in Athenæus, from Hellanicus, which informs us that he obtained the first prize in the musical contests at the Carnean games; and by the testimony of Plutarch, who says, that "no other proof need be urged of the excellence of Terpander in the art of playing upon the cithara, than the register of the Pythic games, from which it appears that he gained four prizes successively at those solemnities. Of the works of this poet only a few fragments now remain.

TERRA AUSTRALIS INCOGNITA, a name for a large unknown continent, supposed to lie towards the south pole, and which for a long time was sought after by navigators. The voyages of Captain Cook have ascertained this matter as much as it probably ever will be. (See *South Sea; Cook's Discoveries*, N° 47, 48, 68, 69; and AMERICA, N° 4). On this subject Captain Cook expresses himself as follows: "I had now made the circuit of the Southern ocean in a high latitude, and traversed it in such a manner as to leave not the least room for the possibility of there being a continent, unless near the pole, and out of the reach of navigation. By twice visiting the tropical sea, I had not only settled the situation of some old discoveries, but made there many new ones, and left, I conceive, very little more to be done even in that part. Thus I flatter myself, that the intention of the voyage has in every respect been fully answered; the southern hemisphere sufficiently explored; and a final end put to the searching after a southern continent, which has at times engrossed the attention of some of the maritime powers for near two centuries past, and been a favourite theory amongst the geographers of all ages. That there may be a continent, or large tract of land near the pole, I will not deny: on the contrary, I am of opinion there is; and it is probable that we have seen a part of it. The excessive cold, the many islands, and vast floats of ice, all tend to prove that there must be land to the south; and for my persuasion that this southern land must lie or extend farthest to the north, opposite to the southern Atlantic and Indian oceans, I have already assigned some reasons; to which I may add, the greater degree of cold experienced by us in these seas than in the Southern Pacific ocean under the same parallels of latitude."

Terra Firma, in *Geography*, is sometimes used for a continent, in contradistinction to islands.

Terra Firma, otherwise called *New Castile*, or *Castella del Oro*, a country of America, bounded on the north by the North sea and part of the Atlantic ocean, by the same sea and Guiana on the east, by the country of the Amazons and Peru on the south, and by the Pacific ocean and Veragua on the west, including the provinces better known under the name of Caraccas, Venezuela, Santa Martha, and Santa Fe, &c. It lies between 62 and 82 degrees of west longitude, and between the equator and 12 degrees of north latitude. It had the name of *Castella del Oro* from the quantity of gold found in the districts of Uraba and other parts; and was first discovered by the celebrated Columbus in his third voyage.

The climate is neither pleasant nor healthy; the inhabitants one part of the year being scorched by the most intense and burning heat, and the other almost drowned with perpetual floods of rain, pouring from the sky with such violence as if a general deluge was to ensue.

In so large a tract of country the soil must necessarily vary. Accordingly, in some parts it is a barren sand, or drowned mangrove land, that will scarce produce any kind of grain; in others it yields Indian corn, balms, gums, and drugs, almost all manner of fruits as well of Old as of New Spain, sugar, tobacco, Brasil wood, and several other kinds of dyeing woods; a variety of precious stones, particularly emeralds and sapphires; venison and other game. The plantations of cacao, or chocolate nuts, in the district of the Caraccas, are esteemed the best in America. The mountains abound with tygers, and, according to some, with lions, and great numbers of other wild beasts. The rivers, seas, and lakes, teem with fish, and also with alligators; and the bowels of the earth were once furnished with the richest treasures, now almost exhausted. The same may be said of the pearl fisheries on the coast, which are far from being so profitable now as formerly.

Terra Firma is a very mountainous country. Terra Firma Proper, in particular, consists of prodigious high mountains, and deep valleys flooded more than half the year. The mountains in the provinces of Carthagena and St Martha, according to Dampier, are the highest in the world: being seen at sea 200 miles off: from these runs a chain of hills of almost equal height, quite through South America, as far as the straits of Magellan, called the *Cordilleras des Andes*. The province of Venezuela also, and district of the Caraccas, the most northerly parts of South America, are almost a continued chain of hills, separated by small valleys, pointing upon the coast of the North sea. A chain of barren mountains, almost impassable, runs through the province of Popayan from north to south, some whereof are volcanoes; but towards the shores of the Pacific ocean it is a low country, flooded great part of the year.

The principal rivers of Terra Firma are, the Darien, Chagre, Santa Maria, Conception, Rio Grande or Magdalena, Maricaibo, and Oroonoko.

Terra Firma contains the provinces of Terra Firma Proper or Darien, of Carthagena, St Martha, Rio de la Hacha, Venezuela, Comana, New Andalusia or Paria, New Granada, and Popayan.

Terra Firma Proper lies in the form of a crescent, about the spacious bay of Panama, being the isthmus which joins South and North America; and extending in length between the two seas 300 miles, but in breadth, where the isthmus is narrowest, only 60. Here are found gold mines, gold sands, and fine pearls; and many fruitful valleys. The chief places are Panama and Porto Bello.

This country has been the scene of a bloody contest, since 1810, between the Spanish authorities and the inhabitants. The struggle has been greatest in the eastern parts, in the province of Caraccas, but is now

(1819) extended to Santa Fe, and may be expected soon to issue in the total subversion of the Spanish power. See CARACCAS, SUPPLEMENT.

TERRA Japonica, or *Cutechu*, a drug which, was formerly supposed to be an extract from the seeds of the areca catechu, is obtained from the mimosa catechu. See MATERIA MEDICA *Index*.

TERRA Puzzolana. See PUZZOLANA.

TERRÆ Filius, Son of the Earth, a student of the university of Oxford, formerly appointed in public acts to make satirical and jesting speeches against the members thereof, to tax them with any growing corruptions, &c.

TERRACE, a walk or bank of earth, raised in a garden or court to a due elevation for a prospect. The name is also given to the roofs of houses that are flat, and whereon we may walk.

TERRAQUEOUS, in *Geography*, a name given to our globe, because consisting of land and water.

Kirwan's Mineralogy.

TERRAS, or TARRAS, in *Mineralogy*, a species of argillaceous earth, differing little from puzzolana, but in being more compact and hard, porous and spongy. It is generally of a whitish yellow colour, and contains more heterogeneous particles, as spar, quartz, shoerl, &c. and something more calcareous earth; it effervesces with acids, is magnetic, and fusible *per se*. When pulverized, it serves as a cement, like puzzolana. It is found in Germany and Sweden.

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A species of red earth has been found in the parish of St Elizabeth in Jamaica, which turns out to be an excellent substitute for terras or puzzolana earth, and may therefore be of great value to the inhabitants of the West Indies.

One measure of this earth, mixed with two of well slaked lime, and one of sand, forms a cement that answers extremely well for buildings in water, for it soon hardens and becomes like a stone.

TERRASON, ABBE JOHN, a French writer, born at Lyons in 1669. He distinguished himself in the dispute concerning Homer, between La Motte and Madame Dacier, by writing a *Dissertation contre l'Iliade*. He wrote a political and moral romance called *Sethos*, full of learning and philosophy; and another capital work of his is a French translation of Diodorus Siculus. He died in 1750.

TERRE *Verte*, in the colour-trade, the name of a green earth much used by painters, both singly for a good standing green, and in mixture with other colours. The name is French, and signifies, "green earth."

It is an indurated clay, of a deep bluish green colour, and is found in the earth, not in continued strata or beds, as most of the other earths are, but in large flat masses of different sizes, imbedded in other strata; these break irregularly in the cutting, and the earth is generally brought out of the pit in lumps of different sizes. It is of a fine, regular and even structure, and not very hard. It is of an even and glossy surface, very smooth to the touch, and in some degree resembling the morochthus or French chalk, but adhering firmly to the tongue. It does not stain the hand in touching it; but being drawn along a rough surface, it leaves an even white line, with a greenish cast.

It does not effervesce with acids, and burns to a dusky brown colour. It is dug in the island of Cyprus, and in many parts of France and Italy. That from the neighbourhood of Verona has been esteemed the best in the world; but of late there has been some dug in France that equals it. There is also an earth dug on Mendip Hills, in the sinking for coal, which, though wholly unobserved, is nearly, if not wholly, of equal value. When scraped, and the finer parts separated, it is ready to be made up with oil for the use of the painters, and makes the most true and lasting green of any simple body they use.

TERRESTRIAL, something partaking of the nature of earth, or belonging to the globe of earth; thus we say, the terrestrial globe, &c.

TERRIER, a small hound to hunt the fox or badger; so called because he creeps into the ground, as ferrets do into the coney-burrows, after the fox, &c.

TERRITORY, in *Geography*, denotes an extent or compass of land, within the bounds or belonging to the jurisdiction of any state, city, or other subdivision of a country.

TERROR. See FEAR and FRIGHT.

TERTIAN FEVER. See MEDICINE, N° 126.

TERTULLIAN, or QUINTUS SEPTIMUS FLORENS TERTULLIANUS, a celebrated priest of Carthage, was the son of a centurion in the militia, who served as proconsul of Africa. He was educated in the Pagan religion; but being convinced of its errors, embraced Christianity, and became a zealous defender of the faith. He married, it is thought, after his baptism. Afterwards he took orders, and went to Rome; where, during the persecution under the emperor Severus, he published his Apology for the Christians, which is, in its kind, a masterpiece of eloquence and learning; and at the beginning of the third century he embraced the sect of the Montanists. He lived to a very great age, and died under the reign of Antoninus Caracalla, about the year 216. Many of his works are still extant, in all of which he discovers a great knowledge of the Holy Scriptures, a lively imagination, a strong, elevated, and impetuous style, great eloquence and strength of reasoning; but is sometimes obscure. His Apology and Prescriptions are most esteemed. The best editions of his works are those of Rigault: especially that of Venice in 1746, folio. Pamelius and Alix, Mr Thomas, and the Sieur du Fossé, have written his life; and Rigault, M. de l'Aube Epine, Father Petau, and other learned men, have published notes on his works.

TERUNCIUS, in antiquity, a very small brass coin in use among the Romans.

The inconvenience of such very small pieces being soon found, the teruncius became disused, but its name is still retained in reckoning, and thus it became a money of account. The teruncius at first was a quarter of the as, or libra; hence, as the as contained twelve ounces, the teruncius contained three, whence the name, which is formed of the Latin *tres unciæ*. Teruncius was also used for the quarter of the denarius; so that when the denarius was at ten ases, the teruncius was worth two and a half; and when the denarius was risen to sixteen, the teruncius was worth four. See DENARIUS.

TESSELATED PAVEMENTS, those of rich mosaic work, made of curious square marbles, bricks, or tiles, called *tesselæ* from their resembling dice.

TESSERA, in Roman antiquity, denoted in its primary sense a cube or dye; so called from the Greek word τετταρα or τεσσερα *four*; respect being had to its number

number of sides, distinct from the two horizontal planes above and below. And it was thus distinguished from the talus, which being round at each end, contained only four planes or faces on which it could stand; and therefore when thrown had no more than two side faces in view. Hence *ludere talis et ludere tesseris*, are spoken of by Roman writers as two different games. The syllable TES occurs often in Roman inscriptions. The word *tessera* was applied to many other things, not so much from a similitude in the figure, as from the relation they bore to some other things of which they were the sign or token; as the points on the upper plane of the dye denoted the good or ill success of the cast.

The *tessera hospitalis* was either public or private. As to the former, we find among the inscriptions published by Gruter instances of two municipal towns which put themselves under the patronage of the Roman governor; and the reciprocal engagement between them, engraved on two copperplates, in the form of an oblong square, with a pediment at the top is called in both *tessera hospitalis*. The design of it was to cultivate or maintain a lasting friendship between private persons and their families; and gave a mutual claim to the contracting parties and their descendants of a reception and kind treatment at each other's houses, as occasion offered. For which end these tesseræ were so contrived as best to preserve the memory of that transaction to posterity. And one method of doing this was by dividing one of them lengthwise into two equal parts; upon each of which one of the parties wrote his name, and interchanged it with the other. From this custom came the prevailing expression *tesseram hospitalem confringere*, applied to persons who had violated their engagements.

The *tesseræ frumentariæ* were small tallies given by the emperors to the populace at Rome, entitling them to the reception of a quantity of corn from the public at stated seasons. The person who had the inspection of these was called *tesserarius*. They were made of wood and of stone.

There was another kind of tessera which intitled persons to a sight of the public games and other diversions, usually made in the form of an oblong square.

The *tessera militaris* was a signal given by the general or chief commander of an army, as a direction to the soldiers for executing any duty or service required of them. This, upon urgent occasions, was only vocal; but, in ordinary cases, it was written on a tablet, commonly made of wood. Besides these civil and military tesseræ, there are others which relate to religious affairs, and may be called *sacred*.

TESSON, or TESTON. See TESTER.

TESSOUWA, a considerable town in Africa, situated east of Mourzouk, the capital of the kingdom of Fezzan. Near this town a deep and rapid stream is said to have existed, but was overwhelmed by the moving sands so frequent in Africa.

TEST, a vessel used in metallurgy for absorbing the scoriæ of metallic bodies when melted. See CUPEL, under ORES, *Reduction of*.

Test-Act, in *Law* is the statute 25 Car. II. cap. 2. which directs all officers, civil and military, to take the oaths, and make the declaration against transubstantiation, in the court of King's Bench, or Chancery, the next term, or at the next quarter-sessions, or (by subsequent statutes) within six months after their admission; and also within the same time to receive the sacrament of the Lord's Supper, according to the usage of the church of England, in some public church, immediately after divine service or sermon, and to deliver into court a certificate thereof signed by the minister and churchwarden, and also to prove the same by two credible witnesses, upon forfeiture of 500l. and disability to hold the said office.

The avowed object of this act was to exclude from places of trust all members of the church of Rome; and hence the dissenters of that age, if they did not support the bill when passing through the two houses of parliament, gave it no opposition. For this part of their conduct they have been often censured with severity, as having betrayed their rights from resentment to their enemies. But is this a fair state of the case? Were any rights in reality betrayed? That the dread of a popish successor and of popish influence was the immediate and urgent cause of passing the *test-act*, is indeed true; but that the legislature, when guarding against an impending evil, had not likewise a retrospect to another from which they had so recently been delivered, is not so evident. If it be proper to support an established church as a branch of the constitution, and if the test-act be calculated to afford that support to the church of England, it is probable that the deliberations of parliament were as much influenced by the dread of puritanic fury, and a renewal of the covenant, as by apprehensions of a persecution from a popish king and popish councils. That the members of the church established by law in England had as much reason to dread the effects of power in the hands of Puritans as in the hands of Papists, no impartial man will controvert, who is not a stranger to that period of our national history; and that it was the duty of the legislature by every method in their power to provide for the security of the constitution against the machinations of both its enemies, will be admitted by all but such as are in love with anarchy on the one hand, or with despotism on the other.

Many people, when they talk or write of the *test-act*, seem to think that it was framed in opposition to the *religious* opinions of the church of Rome; and finding the Protestant dissenters, who abhor these opinions, deprived by it of their civil *rights*, they speak with indignation of a law which confounds the innocent with the guilty. But all this proceeds from a palpable mistake of the purpose of the test. As the legislature had no authority to make laws against *any opinions whatever*, on account of their being false in theology; so it is not to be supposed that, in their deliberations on the TEST-ACT, the members of that august body took into their consideration the comparative orthodoxy of the distinguishing tenets of the Catholics and Puritans. As a religious sect they might esteem the latter much more than the former; but if they found that both had combined with their theological doctrines opinions respecting civil and ecclesiastical government, inconsistent with the fundamental principles of the English constitution, they had an undoubted right to enact a law, by which none should be admitted to offices, in the execution of which they could injure the constitution, without previously giving security that their administration should support it in all its branches. It had not then been doubted, nor is there reason to doubt yet, but that an established religion is necessary, in conjunction with civil govern-

Test.

ment, to preserve the peace of society; and therefore in every well regulated state an established religion must be supported, not because it is the duty of the civil magistrate to conduct his subjects to future happiness, but because he cannot without such an establishment preserve among them present tranquillity. The establishment which must best answer this purpose, is that which, teaching the great and unchangeable duties of morality, is most acceptable in its government and forms of worship to the majority of the people; and therefore in giving a legal establishment to one constitution of the church in preference to all others, it is only this circumstance, and not the comparative purity of the rival churches, viewed merely as ecclesiastical corporations, to which it is the business of the legislature to pay attention. At the time when the *test act* passed the two houses of parliament, the established church of England was certainly more acceptable to the great body of the people and to all ranks in the state, than any one of the sects, whether Catholic or Protestant, which dissented from her; and therefore it was the duty of the legislature to preserve to that church all her privileges and immunities, and to prevent those hostile sectaries from doing her injury in the discharge of any civil office with which they might be entrusted. It was with this view that the *test-act* was formed; and it is with the same view that the legislature has hitherto rejected every petition for its repeal. In doing so, it deprives no man of his *rights*, far less of rights which *conscience* calls upon him to maintain at every hazard; for the rights of individuals to hold civil offices are not inherent, but derived from the legislature, which of course must be the judge upon what terms they are to be held. The legislature of England has excluded from many offices, civil and military, every man who will not give security, that in the discharge of his public duty he will support the church established by law; and as the test of his intention it requires him, before he enters upon his office, to renounce the doctrine of transubstantiation, and receive the sacrament of the Lord's Supper in some public church, according to the liturgy of the church of England. Whether this be the most proper test that could have been enacted, may well be questioned; but that in a country abounding with sectaries of various denominations, who agree in nothing but venomous hostility to the religious establishment, *some* test is necessary, seems incontrovertible, if it be the business of the legislature to preserve the public peace.

To this it will be replied, That the public peace in Scotland is preserved without a test, and that therefore a test cannot be necessary in England. This is plausible, but not conclusive. For 40 years after the Revolution, there was in Scotland no denomination of Christians but those of the Presbyterian church, established by law, the Protestant Episcopalians, whose church had been established prior to that event, and the adherents to the church of Rome. The Episcopalians and Papists were effectually excluded from every office in which they could injure the ecclesiastical establishment, by the several restrictions under which they were laid, on account of their attachment, real or supposed, to the abdicated family of Stuart. The penal laws operated upon them more powerfully than a religious test. It is to be observed too that in the church of Scotland, though her clergy are better provided for than any other parochial clergy perhaps in Europe (A), there is nothing of that splendour and temporal power which in England excite envy to clamour against the establishment, under the pretence of maintaining the cause of religious liberty. Yet even in Scotland a religious test is occasionally exacted of civil officers. In the royal boroughs of that part of the united kingdom, no man can hold the office of a magistrate without previously swearing the burgess-oath (see SECEDER, N° 8.); and every instructor of youth, whether in schools or colleges, may be called upon to qualify himself for his office, by subscribing the established Confession of Faith. The burgess-oath is a more effectual test than that which is required of magistrates in England; for a man might with a safe conscience receive the sacrament of the Lord's Supper occasionally in a church "at which he would not swear to abide and defend the same to his *life's end*." This test appears to us to be necessary in boroughs, where faction is commonly blended with fanaticism; and if those sectaries which, at their first appearance in 1732, were insignificant, if not contemptible, continue to multiply, and to imbibe principles much more pernicious than those which were held by their fathers, it may perhaps be found expedient to extend some test over the whole country.

We do not, however, by any means, wish to see the sacramental test introduced into Scotland. A test may be necessary to secure to the church all her rights and immunities; but to receive the sacrament can give her no such security, whilst it leads inevitably to the profanation of a sacred ordinance. A much better test would be, to require every man, before he be admitted to an executive office, to swear that in the discharge of it he will be careful to maintain all the rights and privileges of the church established by law. Such an oath no sensible and peaceable dissenter could refuse; for it would not bind him to communicate with the established church; and he cannot be ignorant that it belongs not to the executive government, but to the legislature, to determine what shall be the religion of the state. On this account, we cannot help thinking that the members of

(A) There are indeed many livings in the church of England, and probably in other churches, to which nothing in the church of Scotland can be compared in respect of emolument; but these rich benefices bear no proportion to the number of those which, in this age of unavoidable expence, cannot afford to the incumbents the means of decent subsistence as gentlemen. In the church of Scotland many livings amount to 200l. each annually; and we have reason to hope, that when the present plan for augmenting the stipends of the clergy has been extended over Scotland, very few will be below 100l.; whilst in England the vicarages and small rectories, from which we have reason to believe that the incumbents reap not 80l. a-year, greatly exceed in number all the livings in Scotland. Nay we doubt if there be not upwards of a thousand livings in England and Wales from which the rector or vicar derives not above 50l. annually.

of the legislative body should be subjected to no religious test whatever, that they may be at freedom to reform the corruptions of the church, or to exchange one establishment for another, should they find such exchange expedient. If this reasoning be just, it will be difficult to vindicate that clause of 25 Car. II. and of 1 Geo. I. in which it is enacted, that no member shall vote or sit in either house of parliament, till he hath, in the presence of the house, subscribed and repeated the declaration against transubstantiation, the invocation of saints, and the sacrifice of the mass. The church of Rome is indeed a very corrupt society; but if it be not for the purity of her doctrines and government that any church is established in preference to all others, why should that particular church be precluded from the possibility of obtaining a legal establishment in Great Britain, even though she were to become most acceptable to the majority of all ranks in the kingdom? The English Catholics have unquestionably greater reason to complain of this test, than either they or the dissenters have to complain of the law which requires every civil and military officer to receive the Lord's Supper in the established church.

Test for Acids and Alkalies. See CHEMISTRY.

Test Liquors for Wines. See WINE.

TESTACEA, in the Linnæan system, comprehends the third order of vermes, or shell-fish. See CONCHOLOGY *Index*.

TESTACEOUS, in *Natural History*, an epithet synonymous with TESTACEA. See above.

TESTAMENT, or LAST WILL. Testaments both Justinian and Sir Edward Coke agree to be so called, because they are *testatio mentis*: an etymon which seems to savour too much of conceit; it being plainly a substantive derived from the verb *testari*, in like manner as *juramentum*, *incrementum*, and others, from other verbs. The definition of the old Roman lawyers is much better than their etymology; *voluntatis nostræ justa sententia de eo, quod quis post mortem suam fieri velit*: which may be thus rendered into English, "the legal declaration of a man's intentions, which he wills to be performed after his death." It is called *sententia*, to denote the circumspection and prudence with which it is supposed to be made: it is *voluntatis nostræ sententia*, because its efficacy depends on its declaring the testator's intention, whence in English it is emphatically styled his *will*; it is *justa sententia*; that is, drawn, attested, and published, with all due solemnities and forms of law: it is *de eo, quod quis post mortem suam fieri velit*, because a testament is of no force till after the death of the testator.

Blackst. Comment. vol. ii.

These testaments are divided into two sorts; written, and verbal or nuncupative; of which the former is committed to writing: the latter depends merely upon oral evidence, being declared by the testator in *extremis*, before a sufficient number of witnesses, and afterwards reduced to writing.

But as nuncupative wills and CODICILS (which were formerly more in use than at present when the art of writing is become more general) are liable to great impositions, and may occasion many perjuries, the statute of frauds, 29 Car. II. c. 3. enacts, 1. That no written will shall be revoked or altered by a subsequent nuncupative one, except the same be in the lifetime of the testator reduced to writing, and read over to him, and approved; and unless the same be proved to have been so done by the oaths of three witnesses at the least, who, by statute 4 and 5 Anne, c. 16. must be such as are admissible upon trials at common law. 2. That no nuncupative will shall in anywise be good, where the estate bequeathed exceeds 30l. unless proved by three such witnesses, present at the making thereof (the Roman law requiring seven), and unless they or some of them were specially required to bear witness thereto by the testator himself; and unless it was made in his last sickness, in his own habitation or dwelling-house, or where he had been previously resident ten days at the least, except he be surprised with sickness on a journey, or from home, and dies without returning to his dwelling. 3. That no nuncupative will shall be proved by the witnesses after six months from the making, unless it were put in writing within six days. Nor shall it be proved till fourteen days after the death of the testator, nor till process hath first issued to call in the widow, or next of kin, to contest it if they think proper. Thus hath the legislature provided against any fraud in setting up nuncupative wills, by so numerous a train of requisites, that the thing itself has fallen into disuse; and hardly ever heard of, but in the only instance where favour ought to be shown to it, when the testator is surprised by sudden and violent sickness. The testamentary words must be spoken with an intent to bequeath, not any loose idle discourse in his illness; for he must require the by-standers to bear witness of such his intention; the will must be made at home, or among his family or friends, unless by unavoidable accident, to prevent impositions from strangers: it must be in his last sickness; for if he recovers, he may alter his dispositions, and have time to make a written will: it must not be proved at too long a distance from the testator's death, lest the words should escape the memory of the witnesses; nor yet too hastily and without notice, lest the family of the testator should be put to inconvenience or surprise.

As to written wills, they need not any witness of their publication. We speak not here of devices of lands, which are entirely another thing, a conveyance by statute, unknown to the feodal or common law, and not under the same jurisdiction as personal testaments. But a testament of chattels, written in the testator's own hand, though it has neither his name nor seal to it, nor witnesses present at its publication, is good; provided sufficient proof can be had that it is his hand-writing. And though written in another man's hand, and never signed by the testator, yet if proved to be according to his instructions and approved by him, it hath been held a good testament of the personal estate. Yet it is the safer and more prudent way, and leaves less in the breast of the ecclesiastical judge, if it be signed or sealed by the testator, and published in the presence of witnesses; which last was always required in the time of Bracton; or rather he in this respect has implicitly copied the rule of the civil law.

No testament is of any effect till after the death of the testator: *Nam omne testamentum morte consummatum est, et voluntas testatoris est ambulatoria usque ad mortem.* And therefore, if there be many testaments, the last will overthrows all the former; but the republication of a former will revoke one of a later date, and establishes the first again.

Regularly, every person hath full power and liberty to make a will, that is not under some special prohibition by law or custom: which prohibitions are principally upon three accounts; for want of sufficient discretion; for want of sufficient liberty and free-will; and on account of criminal conduct.

1. In the first species are to be reckoned infants, under the age of 14 if males, and 12 if females; which is the rule of the civil law For though some of our common lawyers have held that an infant of any age (even four years old) might make a testament, and others have denied that under 18 he is capable; yet as the ecclesiastical court is the judge of every testator's capacity, this case must be governed by the rules of the ecclesiastical law. So that no objection can be admitted to the will of an infant of 14, merely for want of age; but if the testator was not of sufficient discretion, whether at the age of 14 or 24, that will overthrow his testament. Madmen, or otherwise *non compotes*, idiots or natural fools, persons grown childish by reason of old age or distemper, such as have their senses besotted with drunkenness,—all these are incapable, by reason of mental disability, to make any will so long as such disability lasts. To this class also may be referred such persons as are born deaf, blind, and dumb; who, as they have always wanted the common inlets of understanding, are incapable of having *animum testandi*, and their testaments are therefore void.

2. Such persons as are intestable for want of liberty or freedom of will, by the civil law are of various kinds; as prisoners, captives, and the like. But the law of England does not make such persons absolutely intestable; but only leaves it to the discretion of that court to judge upon the consideration of their particular circumstances of duress, whether or no such persons could be supposed to have *liberum animum testandi*. And with regard to feme-coverts, our laws differ still more materially from the civil. Among the Romans there was no distinction; a married woman was as capable of bequeathing as a feme-sole. But with us a married woman is not only utterly incapable of devising lands, being excepted out of the statute of wills, 34 and 35 Hen. VIII. c. 5. but also she is incapable of making a testament of chattels, without the license of her husband. For all her personal chattels are absolutely his own; and he may dispose of her chattels real, or shall have them to himself, if he survives her: it would be therefore extremely inconsistent to give her a power of defeating that provision of the law, by bequeathing those chattels to another. The queen-consort is an exception to this general rule, for she may dispose of her chattels by will, without the consent of her lord; and any feme-covert may make her will of goods which are in her possession *in auter droit*, as executrix or administratrix; for these can never be the property of the husband: and if she has any pin-money or separate maintenance, it is said she may dispose of her savings thereout by testament, without the controul of her husband. But if a female sole makes her will, and afterwards marries, such subsequent marriage is esteemed a revocation in law, and entirely vacates the will.

3. Persons incapable of making testaments on account of their criminal conduct, are in the first place all traitors and felons, from the time of conviction; for then their goods and chattels are no longer at their own disposal, but forfeited to the king. Neither can a *felo de se* make a will of goods and chattels, for they are forfeited by the act and manner of his death; but he may make a devise of his lands, for they are not subject to any forfeiture. Outlaws also, though it be but for debt, are incapable of making a will so long as the outlawry subsists, for their goods and chattels are forfeited during that time. As for persons guilty of other crimes, short of felony, who are by the civil law precluded from making testaments (as usurpers, libellers, and others of a worse stamp), at the common law their testaments may be good. And in general the rule is, and has been so at least ever since Glanvil's time, *quod libera sit cujuscunque ultima voluntas*.

Testaments may be avoided three ways: 1. If made by a person labouring under any of the incapacities before-mentioned; 2. By making another testament of a later date; and, 3. By cancelling or revoking it. For though I make a last will and testament irrevocable in the strongest words, yet I am at liberty to revoke it; because mine own act or words cannot alter the disposition of law, so as to make that irrevocable which is in its own nature revocable. For this, saith Lord Bacon, would be for a man to deprive himself of that which, of all other things, is most incident to human condition; and that is, alteration or repentance. It hath also been held, that, without an express revocation, if a man, who hath made his will, afterwards marries and hath a child, this is a presumptive or implied revocation of his former will which he made in his state of celibacy. The Romans were also wont to lay aside testaments as being *inofficiosa*, deficient in natural duty, if they disinherited or totally passed by (without assigning a true and sufficient reason) any of the children of the testator. But if the child had any legacy, though ever so small, it was a proof that the testator had not lost his memory or his reason, which otherwise the law presumed; but was then supposed to have acted thus for some substantial cause: and in such case no *querela inofficiosi testamenti* was allowed. Hence probably has arisen that groundless vulgar error of the necessity of leaving the heir a shilling, or some other express legacy, in order to disinherit him effectually; whereas the law of England makes no such wild supposition of forgetfulness or insanity; and therefore, though the heir or next of kin be totally omitted, it admits no *inofficiosi* to set aside such a testament.

TESTAMENT, in *Scots Law*. See LAW, N° clxxxi. 2. &c.

TESTAMENT, *Old* and *New*. See BIBLE and SCRIPTURE.

TESTATOR, the person who makes his will and testament.

TESTER, TESTON, the name of a coin struck in France by Louis XII. in 1513, and in Scotland in the time of Francis II. and Mary queen of Scotland, so called from the head of the king, which was engraved upon it. The silver it contained was 11 deniers 18 grains, its weight seven deniers $11\frac{1}{3}$ grains, and its value 10 sols. The coinage of it was prohibited by Henry III. in 1575, when the value of it was augmented to 14 sols six deniers. The teston or tester among us was rated at 12d. in the reign of Henry VIII. and afterwards reduced to 6d.

TESTES, in *Anatomy*, the testicles. See the next article.

TESTICLE (*testis*), a double part in animals of the male kind, serving for the office of generation. See ANATOMY, N° 107.

TESTIMONY. See LOGIC, N° 29. and METAPHYSICS, N° 135—138.

TESTIMONY, in *Law*. See EVIDENCE.

TESTUDO, the TORTOISE, a genus of animals, belonging to the class of amphibia, and order of reptilia. See ERPETOLOGY *Index*.

TESTUDO, in antiquity, was particularly used among the poets &c. for the ancient lyre; because it was originally made by its inventor Mercury, of the back or hollow of the testudo aquatica, or sea-tortoise, which he accidentally found on the banks of the river Nile. See LYRE.

TESTUDO, in the military art of the ancients, was a kind of cover or screen which the soldiers, *e. gr.* a whole company, made themselves of their bucklers, by holding them up over their heads, and standing close to each other. This expedient served to shelter them from darts, stones, &c. thrown upon them, especially those thrown from above, when they went to the assault.

TESTUDO, was also a kind of large wooden tower which moved on several wheels, and was covered with bullock-hides, serving to shelter the soldiers when they approached the walls to mine them, or to batter them with rams. It was called *testudo*, from the strength of its roof, which covered the workmen as the shell does the tortoise.

TETANUS, a dreadful spasmodic disorder, in which the whole body becomes rigid and inflexible. It most commonly proves mortal. See MEDICINE, N° 279.

TETHYS, a genus of insects belonging to the class of vermes, and order of mollusca. See HELMINTHOLOGY *Index*.

TETRACERA, a genus of plants belonging to the class polyandria; and in the natural system ranging under the doubtful. See BOTANY *Index*.

TETRADYNAMIA, (τισσαρες "four," and δυναμις "power"), four powers; the name of the 15th class in Linnæus's Sexual System. See BOTANY *Index*.

TETRAGONIA, a genus of plants belonging to the class icosandria; and in the natural method ranging under the 13th order, *succulentæ*. See BOTANY *Index*.

TETRAGRAMMATION, τιτραγραμματον, a denomination given by the Greeks to the Hebrew name of God יהוה, "*Jehova*," because in the Hebrew it consists of four letters.

TETRAGYNIA, (τισσαρες, "four," and γυνη, "a woman"); the name of an order, or secondary division, in the Sexual System. See BOTANY *Index*.

TETRANDRIA, (τισσαρες, "four," and ανηρ, "a man or husband"); the name of the fourth class in the Linnæan System. See BOTANY *Index*.

TETRAO, a genus of birds belonging to the order of gallinæ. See ORNITHOLOGY *Index*.

TETRODON, a genus of fishes arranged by Linnæus under the class of *amphibia*, and order of *nantes*; but placed by Gmelin under the class of *pisces*, and order of *branchiostegi*. See ICHTHYOLOGY *Index*.

TETRARCH, a prince who holds and governs a fourth part of a kingdom. Such originally was the import of the title *tetrarch*; but it was afterwards applied to any petty king or sovereign; and became synonymous with ethnarch, as appears from the following considerations: 1. That Pliny makes mention of six tetrarchies within the city of Decapolis. 2. That Herod's kingdom was only divided into three parts, which yet were called *tetrarchies*, and the sovereigns thereof, Luke iii. 1. *tetrarchs*. 3. Josephus tells us, that, after the battle of Philippi, Antony, going into Syria, constituted Herod *tetrarch*; and on medals the same Herod is called *ethnarch*.

Josephus's Antiq. b. xiv. c. 23.

TETRASTYLE, in the ancient architecture, a building, and particularly a temple, with four columns in its front.

TETUAN, an ancient and pleasant town of Africa, in the kingdom of Fez, and in the province of Habata. It is pretty well built, and the inhabitants are about 15,000 in number, who call themselves *Andalusians*, and almost all speak Spanish, but they are great pirates. Some say there are 30,000 Moorish inhabitants, and 5000 Jews. W. Long. 5. 26. N. Lat. 35. 27.

TEUCRIUM, GERMANDER, a genus of plants belonging to the class didynamia; and in the natural system ranging under the 42d order, *Verticillatæ*. See BOTANY *Index*.

TEUTHIS, a genus of fishes belonging to the order of abdominales. See ICHTHYOLOGY *Index*.

TEUTONES, or TEUTONI, in *Ancient Geography*, a people always by historians joined with the Cimbri; both seated, according to Mela, beyond the Elbe, on the Sinus Codanus, or Baltic; and there, it is supposed, lay the country of the Teutones, now *Ditmarsh*; diversity of dialects producing the different terms *Teu*, *Tut*, *Dit*, *Tid*, and *Thod*, which in the ancient German language signified *people*. Of these Teutones, Virgil is to be understood in the epithet *Teutonicus*, an appellation which more lately came to be applied to the Germans in general, and later still the appellation *Alemanni*.

The Teutones, in conjunction with the Cimbri and Ambrones, made war on the Romans, and marched towards Italy in the year 101 B. C. We are told, that the Teutones alone were so numerous, that they were six whole days without intermission in passing by the Roman camp. In Transalpine Gaul they engaged the Roman consul Marius; but were defeated with incredible slaughter; 100,000 of them, according to the lowest calculations, being killed on the spot. According to others, the number of those killed and taken prisoners amounted to 290,000. The inhabitants made fences for vineyards of their bones. Their king Teutobochus, said to be a monstrous giant, was taken prisoner and carried to Rome. See GIANT.

TEUTONIC, something belonging to the Teutones. The Teutonic language is supposed to have been the language of the ancient Germans, and hence is reckoned amongst the mother-tongues. See PHILOLOGY N° 219.

TEUTONIC *Order*, an order of military knights, established towards the close of the twelfth century, on the following occasion.—When the emperor Barbarossa engaged in a crusade for the recovery of the Holy Land out of the hands of Saladin, he was followed by great numbers of German volunteers, who from various motives enlisted under his banners. After the death of Barbarossa, the Germans, who had signalized themselves before Acre or Ptolemais, resolved to choose another leader; and at last fixed their choice upon Frederic duke

duke of Suabia, second son to the emperor, and Henry duke of Brabant. Under these generals they behaved with so much bravery, that Henry king of Jerusalem, the patriarch, and several other princes, determined to reward their valour by instituting an order of knighthood in their favour. This was accordingly done; and our new knights had at first the title of the *knights of St George;* afterwards it was thought proper to put them under the tutelage of the Virgin Mary, to whom there was already an hospital dedicated on Mount Zion, for the relief of German pilgrims. From this time they were called *Equites Mariani*, or knights of St Mary. Laws, regulations, and statutes, were drawn up for them by the Christian kings in Syria and the patriarch; and among other obligations it was required, that every person admitted to the privileges of the order should be of noble parentage; that the order should defend the Christian religion and the Holy Land; that they should exercise hospitality towards the Christians in general, but particularly those of their own country; and that they should with all their power endeavour to propagate and extend the Christian faith and the religion of Jesus. In the year 1190, having become rich by donations from the superstitious, they elected their first grand-master, Henry Walpot, a German, who had distinguished himself by his zeal and valour; and their choice was confirmed by the emperor. The following year, Pope Celestine III. confirmed their privileges already granted, giving them the title of the *Teutonic knights of the hospital of St Mary the Virgin*. By the conditions of this bull, they vowed perpetual continence, obedience, and poverty; obligations which it may well be imagined were not very strictly kept. See Poland, N° 59, 61, 67—69, and Prussia, N° 3, 4.

TEWIT. See Tringa, Ornithology *Index*.

TEWKESBURY, a town in Gloucestershire, formerly noted for its monastery, and containing 4820 inhabitants in 1811, with a magnificent church. It is seated at the confluence of the rivers Severn and Avon, has a cotton manufactory, and sends two members to parliament. W. Long. 2. 13. N. Lat. 52. 0.

TEXEL, a town of the United Provinces, in North Holland, seated at the mouth of the Zuyder-Zee, with a good harbour, and a strong fort. It is seated in a fruitful island, known all over the world by the great number of ships that pass this way every day from all parts; it is about six miles long and five broad, lying a little northward of the continent of Holland, between which and the island is one of the principal passages out of the Zuyder-Zee into the ocean. It is defended from the sea by sand hills and strong banks. Most of the soil is applied to feed sheep, of which they have great flocks; and the cheese made of their milk is said to vie with the Parmesan. This island contains several fair villages, and a town on the east side, called *Burch*, strongly fortified and garrisoned, and inhabited chiefly by fishermen. N. Lat. 53. 8. E. Long. 4. 51.

Nugent's Grand Tour, vol. i.

TEXT, a relative term, contradistinguished to gloss or commentary, and signifying an original discourse exclusive of any note or interpretation. This word is particularly used for a certain passage of Scripture, chosen by a preacher to be the subject of his sermon.

TEXTURE, properly denotes the arrangement and cohesion of several slender bodies or threads interwoven or entangled among each other, as in the webs of spiders, or in the cloths, stuffs, &c.

Texture is also used in speaking of any union or constituent particles of a concrete body, whether by weaving, hooking, knitting, tying, chaining, indenting, intruding, compressing, attracting, or any other way. In which sense we say, a close compact texture, a lax porous texture, a regular or irregular texture, &c.

THABOR. See Tabor.

THALES, a celebrated Greek philosopher, and the first of the seven wise men of Greece, was born at Miletus about 640 B. C. In order to improve himself in the knowledge of the sciences, he travelled into Egypt, where he discoursed with the priests and other learned men. Some say that he married; but others observe, that he eluded the solicitations of his mother on this head, by telling her, when he was young, that it was too soon; and afterwards that it was too late. Thales acquired great reputation by his wisdom and learning: he was the first among the Greeks who foretold eclipses of the sun, and made extraordinary discoveries in astronomy. Thales was the author of the Ionian sect of philosophers, who were thus called from his being born at Miletus, a city of Ionia. He maintained that water was the principle of which all the bodies in the universe are composed; that the world was the work of God; and that God sees the most secret thoughts in the heart of man. He said, "That the most difficult thing in the world is to know ourselves; the most easy to advise others; and the most sweet to accomplish our desires. That, in order to live well, we ought to abstain from what we find fault with in others. That the bodily felicity consists in health, and that of the mind in knowledge. That the most ancient of beings is God, because he is uncreated: that nothing is more beautiful than the world, because it is the work of God; nothing more extensive than space, quicker than spirit, stronger than necessity, wiser than time." It was also one of his sentences, "That we ought never to say that to any one that may be turned to our prejudice; and that we should live with our friends as with persons that may become our enemies." He thanked God for three things; that he was born of the human, not of the brute species; a man, and not a woman; a Greek, and not a barbarian. None of the ancient philosophers ever applied themselves more earnestly to the study of astronomy than Thales. Diogenes Laertius reports, that leaving his lodging with an old woman to contemplate the stars, he fell into a ditch; on which the good woman cried, "How canst thou know what is doing in the heavens, when thou canst not perceive what is at thy feet?" He went to see Crœsus, who was marching with a powerful army into Cappadocia, and enabled him to pass the river Halys without making a bridge. Thales died soon after, at about 90 years of age. He composed several treatises in verse, on meteors, the equinoxes, &c. but they are all lost.

THALIA, in Pagan mythology, one of the nine muses. She presided over Comedy; and is represented crowned with a garland of ivy, holding a mask in her hand, and wearing buskins on her feet.

Thalia, a genus of plants belonging to the class monandria; and in the natural system ranging under the 8th order, *Scitamineæ*. See Botany *Index*.

THALICTRUM,

Thalictrum, Thames

THALICTRUM, Meadow-Rue, a genus of plants belonging to the class polyandria; and in the natural system ranging under the 26th order, *Multisiliquæ*. See Botany *Index*.

THAMES, the finest river in Great Britain, which takes its rise from a copious spring, called *Thames Head*, two miles south-west of Cirencester in Gloucestershire. It has been erroneously said, that its name is Isis till it arrives at Dorchester, 15 miles below Oxford, when, being joined by the Thame or Tame, it assumes the name of the Thames, which, it has been observed, is formed from a combination of the words Thame and Isis. What was the origin of this vulgar error, cannot now be traced. Poetical fiction, however, has perpetuated this error, and invested it with a kind of classical sanctity. "It plainly appears (says Camden), that the river was always called *Thames* or *Tems*, before it came near the Thame; and in several ancient charters granted to the abbey of Malmsbury, as well as that of Ensham, and in the old deeds relating to Cricklade, it is never considered under any other name than that of *Thames*." He likewise says, that it occurs nowhere under the name of Isis. All the historians who mention the incursions of Ethelwold into Wiltshire in the year 905, or of Canute in 1016, concur likewise in the same opinion, by declaring, that they passed over the Thames at Cricklade in Wiltshire. It is not probable, moreover, that Thames Head, an appellation by which the source has usually been distinguished, should give rise to a river of the name of Isis; which river, after having run half its course, should reassume the name of Thames, the appellation of its parent spring. About a mile below the source of the river is the first corn-mill, which is called *Kemble Mill*. Here the river may properly be said to form a constant current; which, though not more than nine feet wide in the summer, yet in the winter becomes such a torrent as to overflow the meadows for many miles around. But, in the summer, the Thames Head is so dry, as to appear nothing but a large dell, interspersed with stones and weeds. From Somerford the stream winds to Cricklade, where it unites with many other rivulets. Approaching Kemsford, it again enters its native county, dividing it from Berkshire at Inglesham. It widens considerably in its way to Lechlade; and being there joined by the Lech and Coln, at the distance of 138 miles from London, it becomes navigable for vessels of 90 tons. At Ensham, in its course north-east, to Oxford, is the first bridge of stone; a handsome one, of three arches, built by the earl of Abingdon. Passing by the ruins of Godstow nunnery, where the celebrated Fair Rosamond was interred, the river reaches Oxford, in whose academic groves its poetical name of Isis has been so often invoked. Being there joined by the Charwell, it proceeds south-east to Abingdon, and thence to Dorchester, where it receives the Tame. Continuing its course south-east by Wallingford to Reading, and forming a boundary to the counties of Berks, Bucks, Surry, Middlesex, Essex, and Kent, it washes the towns of Henley, Marlow, Maidenhead, Windsor, Eton, Egham, Staines, Laleham, Chertsey, Weybridge, Shepperton, Walton, Sunbury, East and West Moulsey, Hampton, Thames Ditton, Kingston, Teddington, Twickenham, Richmond, Isleworth, Brentford, Kew, Mortlake, Barnes, Chiswick, Hammersmith, Putney, Fulham, Wandsworth, Battersea, Chelsea, and Lambeth. Then, on the north bank of the river, are Westminster and London, and, on the opposite side, Southwark; forming together one continued city, extending to Limehouse and Deptford; and hence the river proceeds to Greenwich, Erith, Greenhithe, Gray's Thurrock, Gravesend, and Leigh, into the ocean. It receives in its course from Dorchester the rivers Kennet, Loddon, Coln, Wey, Mole, Wandle, Lea, Roding, Darent, and Medway. The jurisdiction of the lord mayor of London over the Thames extends from Coln ditch, a little to the west of Staines, to Yendal or Yenleet to the east, including part of the rivers Medway and Lea; and he has a deputy, named the water bailiff, who is to search for and punish all offenders against the laws for the preservation of the river and its fish. Eight times a-year the lord mayor and aldermen hold courts of conservance for the four counties of Surry, Middlesex, Essex, and Kent. Though the Thames is said to be navigable 138 miles above the bridge, yet there are so many flats, that in summer the navigation westward would be entirely stopped, when the springs are low, were it not for a number of locks. But these are attended with considerable expence; for a barge from Lechlade to London pays for passing through them 13l. 15s. 6d. and from Oxford to London 12l. 18s. This charge, however, is in summer only, when the water is low; and there is no lock from London bridge to Bolter's lock; that is, for $51\frac{1}{2}$ miles above the bridge. The plan of new cuts has been adopted, in some places, to shorten and facilitate the navigation. There is one near Lechlade, which runs nearly parallel to the old river, and contiguous to St John's bridge; and there is another a mile from Abingdon, which has rendered the old stream toward Culham bridge useless. But a much more important undertaking has lately been accomplished; namely, the junction of this river with the Severn. A canal had been made, by virtue of an act of parliament in 1730, from the Severn to Wallbridge, near Stroud. A new canal now ascends by Stroud, through the vale of Chalford, to the height of 343 feet, by means of 28 locks, and thence to the entrance of a tunnel near Sapperton, a distance of near eight miles. The canal is 42 feet in width at top and 30 at the bottom. The tunnel (which is extended under Sapperton hill, and under that part of Earl Bathurst's grounds called *Halleywood*, making a distance of two miles and three furlongs) is near 15 feet in width, and can navigate barges of 70 tons. The canal descending hence 134 feet, by 14 locks, joins the Thames at Lechlade, a distance of above 20 miles. In the course of this vast undertaking, the canal, from the Severn at Froomlade to Inglesham, where it joins the Thames, is a distance of more than 30 miles. The expence of it exceeded the sum of 200,000l. of which 3000l. are said to have been expended in gunpowder alone, used for the blowing up of the rock. This new canal was completed in 1789, in less than seven years from its commencement. A communication, not only with the Trent, but with the Mersey, has likewise been effected by a canal from Oxford to Coventry; and an act of parliament has passed to extend another canal from this, at Braunston, to the Thames at Brentford. This is to be called *The Grand Junction Canal*. On the extensive advantages resulting from these navigable communications from the metropolis with the ports of Bristol, Liverpool, Hull, &c. and

Brooke's Gazetteer.

Thames, Thane.

and the principal manufacturing towns in the inland parts of the kingdom, it is needless to expatiate. The tide flows up the Thames as high as Richmond, which, following the winding of the river, is 70 miles from the ocean; a greater distance than the tide is carried by any other river in Europe. The water is esteemed extremely wholesome, and fit for use in very long voyages, during which it will work itself perfectly fine.

THAMES is also the name of a river in the state of Connecticut in America. See the article CONNECTICUT.

THANE, or THANUS, a name given to the nobility in Britain before the time of William the Conqueror. It signifies a minister or honourable retainer, from the verb *thenian*, "to minister." There were several degrees of nobility among the Anglo-Saxons; but those most commonly mentioned are the king's thanes and the alderman's thanes. The king's thanes seem to have been of three different degrees, according to their different degrees of wealth or favour at court. The alderman's thanes seem to have been of the lowest degree of nobility, and next to them those who were promoted to that dignity from their advancement in the church, from their valour, success in agriculture or commerce: for if a ceorl or farmer applied to learning and attained to priests orders; if he acquitted himself so well as to obtain from a nobleman five hythes of land, or a gilt sword, helmet, and breast-plate, the reward of his valour; or if by his industry he had acquired the property of five hythes of land; or if he applied to trade, and made three voyages beyond sea in a ship of his own, and a cargo belonging to himself, he was denominated a *thane*.

The thanes, who were the only nobility among the Anglo-Saxons, were a very numerous body of men, comprehending all the considerable landholders in England, and filling up that space in society between the ceorls or yeomanry on the one hand, and the royal family on the other; which is now occupied both by the nobility and gentry. In times of war, they constituted the flower of their armies, and in times of peace they swelled the trains of their kings, and added greatly to the splendour of their courts, especially at the three great festivals of Christmas, Easter, and Whitsuntide. From this body all the chief officers, both civil and military, as aldermen, greeves, earls, heretogens, &c. were taken; and to obtain some of these offices was the great object of their ambition. Before they obtained an office, their lands were their only support; and they lived in greater or less affluence, according to the extent of their estates. These they divided into two parts; one of which they called their *inlands*, and the other their *outlands*. Their inlands they kept in their own immediate possession, and cultivated them by the hands of their slaves and villains, in order to raise provisions for their families; their outlands they granted to ceorls or farmers, either for one year, or for a term of years; for which they received a certain stipulated proportion of their produce annually. These customs had long prevailed among their ancestors in Germany, and were adhered to by their posterity in England till the conquest.

Henry's History of Great Britain, vol. ii.

The thanes were under no obligations on account of their lands, except the three following, which were indispensably necessary to the defence and improvement of their country: To attend the king with their followers in military expeditions, to assist in building and defending the royal castles, and in keeping the bridges and highways in proper repair. To these obligations all proprietors of land (even the churchmen for a long time not excepted) were subjected; and these services were considered as due to their country, rather than to the persons of their kings; and were agreed to by all as being necessary to their own preservation and conveniency.

Thane || Theatre.

This title of thane was abolished in England at the conquest, upon the introduction of the feudal system by William. The titles of earl and baron were about the same period introduced into Scotland by Malcolm Canmore, when the title of thane fell into disuse.

THANET, an island of the county of Kent, surrounded by the sea except on the north-east side, where it is bounded by the branches of the river Stour, now inconsiderable to what they were formerly. It contains several villages, and the sea port towns of Margate and Ramsgate, and has the title of an earldom. It is celebrated for being the spot through which arts, sciences, and divine knowledge, came into this happy isle. The Britons called it *Richborough*, from its vicinity to the city of that name, now only a venerable ruin; but the Saxons called it *Thanet*, from fire, having so many beacons erected on it. It is in the north-east part of the county, lies open to the sea on the north and east, with the river Wantsum on the west and south, is about 10 miles long from the North Foreland to Sarre-Bridge, and about 8 broad from Westgate to Sandwich-Ferry. The north part of it is chiefly arable; and the south and west parts consist of marsh or pasture-lands. The soil is generally very fertile, especially in producing the best barley, of which it is computed above 20,000 quarters are annually sent to London.

Lucombe's England's Gazetteer.

THAPSIA, the DEADLY CARROT, a genus of plants belonging to the class *pentandria*, and in the natural system ranging under the 45th order *Umbellatæ*. See BOTANY *Index*.

THAWING, the resolution of ice into its former fluid state by the warmth of the air. See CONGELATION and FROST.

THEA. See TEA.

THEATINES, a religious order in the Romish church, so called from their principal founder John Peter Caraffa, then bishop of Theate, or Chieti, in the kingdom of Naples, and afterwards pope, under the name of Paul IV. The names of the other founders were Gaetan, Boniface, and Consiglieri. These four pious men desiring to reform the ecclesiastical state, laid the foundation of an order of regular clerks at Rome in the year 1524. Pope Clement VII. approved the institution, and permitted the brethren to make the three religious vows, to elect a superior every three years, and to draw up statutes for the regulation of the order. They were the first who endeavoured, by their example, to revive among the clergy the poverty of the apostles and first disciples of our Saviour, and were also the first who assumed the title of *regular clerks*.

THEATRE, a place in which shows or dramatic representations are exhibited.

For the origin of the dramatic art we always turn our eyes to Greece, the nursery of the arts and sciences. It may indeed have been known among more ancient nations, Theatre.

nations, but no records remain sufficient to support this opinion. The different states of Greece asserted their claim to the honour of having given it birth, but the account of the Athenians is most generally received. It derived its origin from the hymns which were sung in the festivals of Bacchus in honour of that deity. While these resounded in the ears of the multitude, choruses of Bacchants and Fauns, ranged round certain obscene images which they carried in triumphal procession, chanted lascivious songs, and sometimes sacrificed individuals to public ridicule.

This was the practice in the cities; but a still greater licentiousness reigned in the worship paid to the same divinity by the inhabitants of the country, and especially at the season when they gathered the fruits of his beneficence. Vintagers, besmeared with wine-lees, and intoxicated with joy and the juice of the grape, rode forth in their carts, and attacked each other on the road with gross sarcasms, revenging themselves on their neighbours with ridicule, and on the rich by publishing their injustice.

Anacharsis's Travels, vol. i.

Among the poets who flourished at that time, some celebrated the great actions and adventures of gods and heroes, and others attacked with asperity the vices and absurdities of individuals. The former took Homer for their model, and supported themselves by his example, of which they made an improper use. Homer, the most tragic of poets, the model of all who have succeeded him, had in the Iliad and the Odyssey brought to perfection the heroic poem, and in his Margites had employed pleasantry. But as the charm of his works depends in a great measure on the passions and motion with which he knew to animate them, the poets who came after him endeavoured to introduce into theirs an action which might excite emotion or mirth in the spectators: some even attempted to produce both, and ventured certain rude essays, which have since been styled indifferently either tragedies or comedies, because they unite the characters of those two dramas. The authors of these sketches have been distinguished by no discovery; they only form in the history of the art a succession of names which it would be useless to recal to light.

The necessity and power of theatrical interest was already known. The hymns in honour of Bacchus, while they described his rapid progress and splendid conquests, became imitative; and in the contests of the Pythian games, the players on the flute who entered into competition were enjoined by an express law to represent successively the circumstances that had preceded, accompanied, and followed the victory of Apollo over Python.

Some years after this regulation, Susarion and Thespis, both born in a small borough of Attica, named *Icaria*, appeared each at the head of a company of actors, the one on a kind of stage, the other in a cart (A). The former attacked the vices and absurdities of his time; and the latter treated more noble subjects, which he took from history.

The comedies of Susarion were in the same taste with those indecent and satirical farces which were afterwards performed in some of the cities of Greece. They were long the favourite entertainment of the country people. Athens did not adopt this species of exhibition until after it was brought to perfection in Sicily.

Thespis had more than once seen in the festivals, in which as yet hymns only were sung, one of the singers, mounted on a table, form a kind of dialogue with the chorus. From this hint he conceived the idea of introducing into the tragedies an actor who, by simple recitals introduced at intervals, should give relief to the chorus, divide the action, and render it more interesting. This happy innovation, together with some other liberties in which he had allowed himself, gave alarm to the legislator of Athens, who was more able than any other person to discern the value or danger of the novelty. Solon condemned a species of composition in which the ancient traditions were disguised by fictions. "If we applaud falsehood in our public exhibitions (said he to Thespis), we shall soon find that it will insinuate itself into our most sacred engagements."

The excessive approbation and delight with which both the city and country received the pieces of Thespis and Susarion, at once justified and rendered useless the suspicious foresight of Solon. The poets, who till then had only exercised their genius in dithyrambics and licentious satire, struck with the elegant forms which these species of composition began to assume, dedicated their talents to tragedy and comedy. Soon after a greater variety was introduced in the subjects of the former of these poems. Those who judged of their pleasures only from habit, exclaimed, that these subjects were foreign to the worship of Bacchus; but the greater number thronged with still more eagerness after the new pieces.

Phrynichus, the disciple of Thespis, made choice of that kind of verse which is most suitable to the drama, was the author of some other changes, and left tragedy in its infancy.

Æschylus received it from his hands enveloped in a rude vestment, its visage covered with false colours, or a mask inexpressive of character, without either grace or dignity in its motions, inspiring the desire of an interest which it with difficulty excited, still attached to the buffooneries which had amused its infant years, and expressing its conceptions sometimes with elegance and dignity, but frequently in a feeble and low style, polluted with gross obscenities.

In his first tragedies he introduced a second actor; and afterwards, copying the example of Sophocles, who had just entered on his theatrical career, he admitted a third, and sometimes even a fourth. By this multiplicity of personages, one of his actors became the hero of the piece, and attracted to himself the principal interest; and as the chorus now held only a subaltern station, Æschylus took care to shorten its part, and perhaps even carried this precaution too far.

He is censured for having admitted mute characters into his drama. Achilles, after the death of his friend, and Niobe, after the destruction of her children, appear on

(A) Susarion represented his first pieces towards the year 580 before Christ. Some years after, Thespis made his first attempts in tragedy, and acted his Alcestis in 536.

on the stage, and remain during several scenes motionless, with their heads covered with a veil, and without uttering a word; but if their eyes had overflown with tears, and they had poured forth the bitterest lamentations, could they have produced an effect so terrible as this veil, this silence, and this abandonment to grief?

It was not sufficient that the noble and elevated style of tragedy should leave in the minds of the auditors a strong impression of grandeur; to captivate the multitude, it was requisite that every part of the spectacle should concur to produce the same effect. It was then the general opinion that nature, by bestowing on the ancient heroes a more lofty stature, had impressed on their persons a majesty which procured them as much respect from the people as the ensigns of dignity by which they were attended. Æschylus therefore raised his actors on high stilts or buskins. He covered their features, which were frequently disagreeable, with a mask that concealed their irregularity. He clothed them in flowing and magnificent robes, the form of which was so decent, that the priests of Ceres have not blushed to adopt it. The inferior actors were also provided with masks and dresses suited to their parts.

Instead of those wretched scaffolds which were formerly erected in haste, he obtained a theatre furnished with machines, and embellished with decorations. Here the sound of the trumpet was reverberated, incense was seen to burn on the altars, the shades of the dead to arise from the tomb, and the furies to rush from the gulfs of Tartarus. In one of his pieces these infernal divinities appeared, for the first time, with masks of a horrid paleness, torches in their hands, serpents intertwined in their hair, and followed by a numerous retinue of dreadful spectres. It is said that, at the sight of them, and the sound of their terrific howlings, terror seized on the whole assembly, women miscarried, and children expired with fear; and that the magistrates, to prevent similar accidents in future, commanded that the chorus should consist only of fifteen actors instead of fifty.

The effect of so many new objects could not but astonish the spectators; nor were they less surprised and delighted at the intelligence displayed in the performance of the actors, whom Æschylus almost always exercised himself. He regulated their steps, and taught them to give additional force to the action by new and expressive gestures.

The progress of the art was extremely rapid. Æschylus was born 525 years before Christ, 11 years after Thespis had acted his Alcestis. He had for competitors Chœrilus Pratenas, and Phrynichus, whose glory he eclipsed, and Sophocles, who rivalled his own. Sophocles was born about the year 497 B. C. about 14 years before Euripides. These carried tragedy to the highest perfection to which it attained among the Greeks. Æschylus painted men greater than they can be, Sophocles as they ought to be, and Euripides as they are.

Invented towards the 50th Olympiad (about 580 B. C.) and adapted to the rude manners of the rustics, comedy ventured not to approach the capital; and if by chance some companies of actors, who were unconnected with any others, found their way into the city, and performed their indecent farces, they were less authorised than tolerated by the government. It was not till after a long infancy that this species of drama began suddenly to make a rapid improvement in Sicily. Instead of a succession of scenes without connection or tendency, the philosopher Epicharmus introduced an action, all the parts of which had a dependence on each other; and conducted his subject, without wandering from it, through a just extent to a determinate end. His pieces, subjected to the same laws of tragedy, were known in Greece, where they were considered as models; and comedy soon shared with her rival the suffrages of the public, and the homage due to genius. The Athenians, especially, received her with the same transports as they would have testified at the news of a victory: many of their poets exercised their genius in this novel species of composition; and their names adorn the numerous list of writers who have been distinguished in comedy from the time of Epicharmus. Such were, among the more ancient, Magnes, Cratinus, Crates, Pherecrates, Eupolis, and Aristophanes. They all flourished in the age of Pericles.

If we peruse the comic pieces which have come down to us, we shall be convinced that the sole object of the authors was to please the multitude. The gods and heroes were travestied, gross and obscene language was often employed, and virulent invectives were often thrown out against individuals of the first rank for genius and virtue. Towards the end of the Peloponnesian war the licentiousness of comedy was restrained. The chorus was laid aside, because the rich citizens were alarmed, and would no longer contribute money to support it, nor provide masks with portraits for exposing individuals.

The poets being thus restrained from mentioning names of living persons on the stage, invented false names. They still exposed real and known characters; and thus gave a more exquisite gratification to the spectators, who were highly amused with finding out the persons intended. The consequence of the law was only to make that done with delicacy which was formerly done in the most indecent and scurrilous manner. Aristophanes, in some of his latest pieces, has given us some good examples of this kind of comedy, which is sometimes called the middle comedy.

Comedy was still liable to abuse, and therefore required farther reformation. As the use of real names had formerly been prohibited, real subjects were also forbidden; and comedy from that time was no longer a fury armed with torches, or a firebrand scattering mischief, but a pleasing and instructive companion. This is called the new comedy. The most eminent among the Greeks in this improved species was Menander. His writings are now lost; but we may form a good estimate of their merit from the comedies of Terence, which are said to have been borrowed from Menander, and to have nearly resembled the original, though inferior in that *vis comica* by which the elegant Grecian was distinguished. The comedy of Menander is that which has been cultivated in modern times.

To give some idea of a Grecian theatre, we shall describe very shortly the theatre of Bacchus in Athens, which was built by the famous architect Philos in the time of Pericles. The part intended for the spectators was of a simicircular form, at the diameter of which was erected the stage. The orchestra occupied the space where the pit in modern theatres is situated, where the

Theatre.

the music, the chorus, and the mimi were placed. It was four feet elevated above the ground. The spectators were arranged in three galleries round all the sides of the orchestra except that next the stage, each gallery containing eight rows of seats. At the farther end of the orchestra, where the stage is erected in modern theatres, stood the thymele or logeon, but projecting a little towards the audience. It was a little higher than the orchestra, and did not extend the whole breadth of it. In some theatres it was only six feet square. Here the principal part of the chorus made their recitations, and in comical interludes the mimi performed. Behind the thymele appeared the stage or proscenion, considerably elevated. No part of this theatre was covered except the stage, and a high gallery called *circys* set apart for the women. The Athenians, being exposed to the weather, came usually with great cloaks, to secure them from the rain or the cold; and for defence against the sun they had the *sciadion*, a kind of parasol, which the Romans used also in the theatres by the name of *umbellæ;* but when a sudden storm arose, the play was interrupted, and the spectators dispersed.

Gentleman's Magazine for 1760.

A sort of tent-work over the entire area of the edifice might have been contrived as a shelter from the rain and a shade from the sun. Such a covering would have obviated the inconveniences of roofed theatres, which obstruct the free communication of the air, and of unroofed theatres, which do not keep out the weather. At Athens the plays were always represented in the daytime, which made the unroofed theatres less inconvenient.

Plays were represented only during the three festivals solemnized in honour of Bacchus. The first of these was celebrated at the Piræus, where some of Euripides's pieces were first performed. The second, which lasted only one day, was kept at the end of January or beginning of February. The third, called the greater *Dionysia*, was celebrated a month after. It continued several days, and attracted a great multitude of spectators. In the festivals which lasted only one day, five or six dramatic pieces, either tragedies or comedies, were performed. But in the greater Dionysia, which continued longer, 12 or 15, and sometimes more, were acted. The performance began early in the morning, and sometimes lasted the whole day.

The chorus, according as the subject demanded, was composed of men and women, old men or youths, citizens or slaves, priests, soldiers, &c. to the number of 15 in tragedy, and 24 in comedy. The chorus came upon the stage preceded by a flute-player, who regulated their steps; sometimes one after the other, but in tragedy more frequently three in front and five in depth, or five in front and three in depth.

The same persons performed both in tragedy and comedy; but, as among ourselves, it was rare to meet with any who excelled in both. The pay of those who had acquired great reputation was considerable. Polus gained a talent in two days (equal to 225l. sterling *). Players of eminence were solicited by different actors of Greece to attend their festivals. If, after making an engagement, they failed, they were obliged to pay a certain sum of money; and if they were absent during the festivals of their own republic, they were condemned to a heavy fine.

* *Plut. in X. Rhet.*

The actors had habits and symbols suited to their parts. Kings wore a diadem, leaned on a sceptre which supported an eagle on its top, and were dressed in long robes of purple or other splendid colours ornamented with gold. Heroes, besides having their stature frequently increased to six feet English †, and their bulk in proportion, were frequently covered with the skin of a lion or a tyger, and armed with swords, quivers, and clubs. All who suffered misfortunes wore a black, brown, or dirty white garment, which frequently hung in tatters. There were various kinds of masks for tragedy, comedy, and satire. These certainly took away the pleasure arising from the expression of the countenance; but at any rate, little pleasure could be derived from this circumstance in a Grecian theatre, from its immense size, and the great distance of the audience from the stage.

† *Arist. in Ran.* v. 1046. *Athen.* lib. v. cap. 7.

Dramatic entertainments were introduced at Rome in the year of the city 391. They were called *ludi scenici*, because they were first acted in a shade formed by the branches and leaves of trees. They were borrowed immediately from Etruria, whence also they received their first players. These Etrurians at first only danced to a flute, without either singing or acting. The Roman youth soon imitated them at their solemn festivals, adding raillery in rude verses, and gestures adapted to the subject. These verses were called *Fescennini*, from Fescennia, a city of Etruria. Livius Andronicus was the first poet who wrote a regular play in Latin. This happened in the year of Rome 512 or 514, about 160 years after the death of Sophocles and Euripides, and 52 after that of Menander. The Grecian model was afterwards introduced and cultivated much by succeeding dramatic writers. This was the model of Menander, for the old and middle comedy was unknown at Rome. As the Romans were only imitators of the Greeks in the dramatic art, as well as in most of the arts and sciences, nothing more is necessary to be said in addition to the account which we have already given of the Grecian stage.

The origin of the English stage is hid in obscurity. It was not, however, copied from the Grecian or Roman; for it was evidently different in form as well as in matter, and may with more propriety be deduced from a Gothic original. It appears that there were theatrical entertainments in England almost as early as the conquest; for we are told by William Stephanides or Fitz-Stephen, a monk, who in the reign of Henry II. wrote his *Descriptio Nobilissimæ Civitatis Londoniæ*, that "London, instead of the common interludes of the theatre, had plays of a more holy kind; representations of the miracles of confessors, and the sufferings of martyrs." At this time there were also certain sets of idle people, who travelled the countries, and were called *Mummers*, a kind of vagrant comedians, whose excellence consisted altogether in mimickry and humour.

Gentleman's Magazine for 1761.

It is probable that, soon after this time, the dramatic representations called *Mysteries* were exhibited: These mysteries were taken from scripture-history: some represented the creation of the world, with the fall of Adam and Eve; some the story of Joseph; and others even the incarnation and sufferings of the Son of God. These pieces were exhibited in a manner so ridiculous as to favour libertinism and infidelity, as appears by a petition of the chaunters of St Paul's Cathedral to Richard II. in 1378, praying, that "some unexpert people might be-

Cibber's Apology for his Life.

Theatre. be prohibited from representing the history of the Old Testament to the prejudice of the said clergy, who had been at great expence to represent it publicly at Christmas."

In the year 1390, the parish clerks of London are said to have played interludes at Skinner's-well on three successive days in July; and, in 1409, to have acted for eight days successively a play concerning the creation of the world, at the same place which thence acquired the name of *Clerkenwell.*

These Mysteries were succeeded by Moralities, in which there were some rude traces of a fable and a moral; and some also of poetry, the virtues, vices, and other affections of the mind being frequently personified.

After these Moralities came what were called Interludes, which made some approaches to wit and humour. Many of these pieces were written by John Heywood, jester to Henry VIII.

In the time of Henry VIII. one or two pieces had been published under the classical names of *Comedy* and *Tragedy*, but they appear not to have been intended for popular use. It was not till the religious ferments had subsided that the public had leisure to attend to dramatic poetry. In the reign of Elizabeth, tragedies and comedies began to appear in form, and could the poets have persevered, the first models were good. *Gorboduc*, a regular tragedy, was acted in 1561; and Gascoigne, in 1566, exhibited *Jocasta*, a translation from Euripides, as also *The Supposes*, a regular comedy, from Ariosto, near 30 years before any of Shakespeare's were printed.

Percy's Relics of Ancient English Poetry.

The people, however, still retained a relish for their old mysteries and moralities, and the popular dramatic poets seem to have made them their models. The graver sort of moralities appear to have given birth to our modern tragedy; as our comedy evidently took its rise from the lighter interludes of that kind. And as most of these pieces contain an absurd mixture of religion and buffoonery, an eminent critic has well deduced from thence the origin of our unnatural tragi-comedies. Even after the people had been accustomed to tragedies and comedies, moralities still kept their ground. One of them, intitled *The New Custom*, was printed so late as 1573. At length they assumed the name of *masques*, and, with some classical improvements, became in the two following reigns the favourite entertainments of the court.

As for the old mysteries, which ceased to be acted after the reformation, they seem to have given rise to a third species of stage exhibition; which, though now confounded with tragedy or comedy, was by our first dramatic writers considered as quite distinct from them both: these were historical plays, or histories; a species of dramatic writing which resembled the old mysteries in representing a series of historical events simply in the order of time in which they happened, without any regard to the three great unities. These pieces seem to differ from tragedy just as much as historical poems do from epic: as the Pharsalia does from the Æneid. What might contribute to make dramatic poetry take this turn was, that soon after the mysteries ceased to be exhibited, there was published a large collection of poetical narratives, called *the Mirror for Magistrates*, wherein a great number of the most eminent characters in English history are drawn relating their own misfortunes. This book was popular and of a dramatic cast; and therefore, as an elegant writer has well observed, might have its influence in producing historic plays. These narratives probably furnished the subjects, and the ancient mysteries suggested the plan. Theatre.

That our old writers considered historical plays as somewhat distinct from tragedy and comedy, appears from numberless passages of their works. "Of late days (says Stow in his Survey of London), instead of those stage plays have been used comedies, tragedies, interludes, and histories, both true and fained." Beaumont and Fletcher, in the prologue to the *Captain*, say,

> "This is nor comedy, nor tragedy,
> "Nor *history*."

Polonius in Hamlet commends the actors as the best in the world, either for tragedie, comedie, historie, pastoral, &c. And Shakespeare's friends, Heminge and Condell, in the first folio edition of his plays, in 1623, have not only intitled their book "Mr William Shakespeare's Comedies, Histories, and Tragedies," but, in their table of contents, have arranged them under those three several heads; placing in the class of histories, "King John, Richard II. Henry IV. two parts, Henry V. Henry VI. three parts, Richard III. and Henry VIII."

This distinction deserves the attention of the critics: for if it be the first canon of sound criticism to examine any work by those rules the author prescribed for his first observance; then we ought not to try Shakespeare's histories by the general laws of tragedy and comedy. Whether the rule itself be vicious or not, is another inquiry; but certainly we ought to examine a work only by those principles according to which it was composed. This would save much impertinent criticism.

Not fewer than 19 playhouses had been opened before the year 1633, when Prynne published his *Histriomastix*. From this writer we learn that tobacco, wine, and beer, were in those days the usual accommodations in the theatre, as now at Sadlers Wells. With regard to the ancient prices of admission, the playhouse called the *Hope* had five different priced seats, from sixpence to half-a-crown. Some houses had penny benches. The two-penny gallery is mentioned in the prologue to Beaumont and Fletcher's *Woman-hater;* and seats of threepence and a groat in the passage of Prynne last referred to. But the general price of what is now called the *Pitt* seems to have been a shilling. The time of exhibition was early in the afternoon, their plays being generally acted by day-light. All female parts were performed by men, no actress being ever seen on the public stage before the civil wars. And as for the playhouse furniture and ornaments, they had no other scenes nor decorations of the stage, but only old tapestry, and the stage strewed with rushes, with habits accordingly; as we are assured in a short Discourse on the English Stage, subjoined to Flecknoe's *Love's-Kingdom*, 1674, 12mo.

(B) For the state of the theatre during the time of Shakespeare, see PLAYHOUSE; where a full account of it

(B) We have been anxious to give as full an account of the ancient English drama as we could: we must not omit

Theatre. it is given from the late valuable edition of our illustrious poet's works by Mr Malone. During the whole reign of James I. the theatre was in great prosperity and reputation: dramatic authors abounded, and every year produced a number of new plays; it became a fashion for the nobility to celebrate their weddings, birthdays, and other occasions of rejoicing, with masques and interludes, which were exhibited with surprising expence; our great architect, Inigo Jones, being frequently employed to furnish decorations, with all the luxuriance of his invention and magnificence of his art. The king and his lords, and the queen and her ladies, frequently performed in these masques at court, and the nobility at their private houses; nor was any public entertainment thought complete without them. This taste for theatrical entertainment continued during great part of the reign of King Charles I.; but, in the year 1633, it began to be opposed by the Puritans from the press; and the troubles that soon after followed entirely suspended them till the restoration of King Charles II. in 1660.

The king, at his restoration, granted two patents, one to Henry Killigrew, Esq. and the other to Sir William Davenant, and their heirs and assigns, for forming two distinct companies of comedians. Killigrew's were called the *King's Servants*, and Davenant's the *Duke's Company*. About ten of the company called the *King's Servants* were on the royal household establishment, having each ten yards of scarlet cloth, with a proper quantity of lace allowed them for liveries; and in their warrants from the lord chamberlain they were styled *gentlemen of the great chamber*.

Till this time no woman had been seen upon the English stage, the characters of women having always been performed by boys, or young men of an effeminate aspect, which probably induced Shakespeare to make so few of his plays depend upon female characters, as they must have been performed to great disadvantage. The principal characters of his women are innocence and simplicity, such are Desdemona and Ophelia; and his specimen of fondness and virtue in Portia is very short. But the power of real and beautiful women was now added to the stage; and all the capital plays of Shakespeare, Fletcher, and Ben Jonson, were divided between the two companies, by their own alternate choice, and the approbation of the court.

The king's servants seem to have been allowed to be the best company; and when the variety of plays began to be exhausted, they drew the greater audiences. Davenant, therefore, to make head against them, first added spectacle and music to action, and introduced a new species of plays, since called *dramatic operas;* among these were, *The Tempest*, *Psyche*, and *Circe;* which, with many others, were set off with the most expensive decorations of scenes and habits, and with the best voices and dancers.

In 1684 the two houses united, and continued together for ten years. In 1690 the play began at four o'clock; and, we are told, the ladies of fashion used to take the evening air in Hyde-park after the representation; by which it appears that the exhibitions were in summer too. The principal actors were, Betterton, Montfort, Kynaston, Sandford, Nokes, Underhill, and Leigh, commonly called *Tony Leigh;* the actresses were, Mrs Betterton, Barry, Leigh, Butler, Montfort, and Bracegirdle; and to this company, in this year, old Cibber was admitted as a performer in the lowest rank. It was a rule with the patentees, that no young person, who offered himself as an actor, should be admitted into pay till after at least half a-year's probation; and Cibber waited full three quarters of a year before he was taken into a salary of 10s. a-week.

In 1695 a new theatre was opened with Mr Congreve's comedy of Love for Love, which had such extraordinary success (says Cibber) that scarce any other play was acted there till the end of the season; but when the season ended, which appears to have begun in June, he does not tell us, and it is indeed difficult to guess; for though the company acted in summer, it seems improbable that they should shut up the house in winter, as it is difficult to conceive any reason for so doing. Congreve was then in such high reputation, that this company offered him a whole share (but into how many shares the whole was divided Colley has not told us) upon condition he would give them a new play every year. This offer he accepted, and received the advantage, though he never fulfilled the condition; for it was three years before he produced the *Mourning Bride*, and three more before he gave them the *Way of the World*.

It is not necessary that we give in detail the remaining history of the English stage: those who are anxious to be acquainted with it may consult Cibber's history of of the stage, continued by Victor, under the title of *A History of the Theatres of London and Dublin from the year* 1730. We shall only mention a few facts respecting the salaries of the players about that period, and the rise of the price of play tickets.

A difference having arisen in 1733 between the managers and actors, most of the actors set up for themselves at the little theatre in the Haymarket. Upon this the managers published the following account of their salaries, to show the public how little room they had to mutiny. To Mr Colley Cibber, from the time of letting his share till he left the stage, 12l. 12s, per week. Mr The. Cibber 5l. and his wife's whole salary till her death, without doing the company any service the greatest part of the winter; and his own also, during the time of his being ill, who performed but seldom till after Christmas. Mr Mills jun. 3l. under the same circumstances with regard to his wife. Mr Mills sen. 1l. per day for 200 days certain, and a benefit clear of all charges. Mr Johnston 5l. Mr Miller 5l. paid him eight weeks before he acted, besides a present of 10 guineas. Mr Harper 4l. and a present of 10 guineas. Mr Griffin 4l. and a present. Mr Shepard 3l. Mr Hallam, for himself and father (though the latter is of little or no service) 3l. Mrs Heron 5l. raised from 40s. last winter, yet refused to play several parts assigned her, *Gentleman's Magazine* for 1733.

omit, however, to inform our readers what Mr Malone says of the old plays, viz. that not one play published before 1592 will bear a second reading; and that exclusive of mysteries, moralities, and translations, there are but 34 pieces extant which were published before that period.

Theatre ‖ Thebes.

her, and acted but seldom this season. Mrs Butler 3l. per week. By these and other salaries, with the incident charges (besides clothes and scenes), the patentees are at the daily charge of 49l. odd money, each acting-day.

Till about the same time, the prices at the theatre were 4s. the boxes, 2s. 6d. the pit, 1s. 6d. the first gallery, and 1s. the second, except upon the first run of a new play or pantomime, when the boxes were 5s. the pit 3s. the first gallery 2s. and the second 1s. But Fleetwood thought fit to raise the prices for an old pantomime, which was revived without expence. This produced a riot for several nights, and at last a number deputed by the pit had an interview with the manager in the green room, where it was agreed, that the advanced prices should be constantly paid at the doors, and that such persons as did not choose to stay the entertainment should have the advanced part of their money returned. This was a very advantageous agreement for the manager; because, when the audience had once paid their money, very few went out or demanded their advanced money, and at last it settled in the quiet payment of the advanced price, as at this day.

It has been frequently a subject of debate, whether the stage be favourable to morals. We do not mean to enter into the controversy; but we shall make an observation or two. It will be allowed by all, that the intention of the players in acting, is to procure money; and the intention of the audience in attending the theatre, is to seek amusement. The players then will only act such plays as they believe will answer their intention. And what sort of plays are these? They are such as correspond with the opinions, manners, and taste, of the audience. If the taste of the audience be gross, therefore the plays will be gross; if delicate and refined, they will be the same. And if we go back to the time of Shakespeare, we shall find that this has been uniformly the case. The conclusion, we draw, is this, if the taste of the audience be pure, free from licentiousness, the plays will be the same, and the stage will be favourable to virtue.

For a view of the progress of the stage, and of the principal dramatic writers, see DRAMA, SUPPLEMENT.

THEBAID, a celebrated heroic poem of Statius, the subject of which is the civil war of Thebes, between the two brothers Eteocles and Polynices; or Thebes taken by Theseus.

THEBES, the name of a celebrated city of ancient Greece. It is supposed to have been built by Cadmus, about the year of the world 2555. This Cadmus, according to the Greeks, was the son of Agenor king of Sidon or of Tyre; but the Sidonians allow him to have been of no higher quality than his cook, and tell us that his wife was a musician at court, with whom he ran away into Greece. The Greek writers tells us, that being commanded by his father to go in search of his daughter Europa, whom Jupiter in the shape of a bull had carried off, and forbid to return without her, he built, or rebuilt, the city of Thebes, after having long sought her in vain. He was at first opposed by the Hyantes and Aones; the former of whom he defeated in battle, and forced to retire into Locris; the latter submitted, and were incorporated among his subjects.

1 Account of Cadmus the founder of Thebes.

Those who endeavour to extract some truth from the multitude of fables in which the early part of the Grecian history is obscured, are of opinion that Cadmus was one of the Canaanites expelled by Joshua; and that he was of the family of the Cadmonites mentioned by Moses and Joshua. He is universally allowed to have introduced the Phœnician letters into Greece, set up the first schools, and introduced brass; which, from him, had the name of *Cadmean* given to it. The government of Thebes continued for a long time monarchical; and the names of a number of its kings have been transmitted to us, with some account of their transactions; but very much obscured by fable.

2 Supposed to be one of the exiled Canaanites.

Though the Thebans had been famed in the early period of their history for their martial achievements, yet in process of time they seem to have degenerated. At the time of the invasion of Xerxes, they were the first people in Greece who were gained over to the Persian interest. On account of this conduct, they became very obnoxious to the other states, especially to the Athenians, whose power and renown increased every day, and threatened at last to swallow them up altogether, The Thebans being in no condition to oppose such a formidable power, put themselves under the protection of the Spartans, who, out of jealousy of the Athenians, readily forgave them; and so grateful were the Thebands for the kindness shown them at this time, that during the whole of the Peloponnesian war Sparta had not a more faithful ally. By these means they not only recovered the government of Bœotia, of which they had been formerly in possession, till deprived of it on account of their siding with the Persians, but their city became one of the first in Greece. By this prosperity the Thebans were so much elated, that, when the peace of Antalcidas came to be signed, they refused to agree to it, as they were thus once more deprived of the government of Bœotia; so that it was not without the utmost difficulty that they were overawed into it by the other states. Not content with forcing them to give up this point, however, the Spartans undertook to change the form of the Theban government, which at this time was a democracy, and accomplished through the treachery of those who had the care of the citadel.

3 The Thebans a degenerate stupid people.

4 Put themselves under the protection of the Spartans.

5 The form of government changed, and the citadel seized by the Spartans.

The Thebans continued under the power of the Spartans for four years; at the ead of which term a conspiracy being formed against them by some of the principal people in the city, among whom was a young nobleman named *Pelopidas*, the Spartans were massacred and driven out, and the citadel regained. During the tumult Epaminondas, afterwards the celebrated general, with a number of the best citizens, joined the party of Pelopidas; and the latter having called a general assembly of the Thebans, proclaimed liberty to them, and exhorted them in the strongest manner to fight for their country. This speech was received with the greatest acclamations; Pelopidas was unanimously proclaimed the preserver of Thebes, and was charged with the management of the war which was then to be declared against Sparta.

6 The Thebans recover their liberty under Pelopidas.

These transactions so much exasperated the Spartans, that they immediately sent their king Cleombrotus against them, though it was then the depth of winter. The Athenians, in the mean time, who had hitherto assisted the Thebans, declined any farther connection, lest they should draw upon themselves the resentment of the

7 War with Sparta.

Thebes. the Spartans. But they were soon after determined to act again on the same side, by an attempt which the Spartan general, Sphodnas, had rashly made on the Pyræus or harbour of Athens. Thus, by means of the Athenians, a powerful diversion was made in favour of the Thebans who gradually recovered all the towns of Bœotia, and at length began to act offensively against their enemies, and made a powerful invasion in Phocis. They had now many sharp encounters with them; which, though they did not amount to decisive battles,
8 The Spartans defeated by Pelopidas. yet did not fail to raise their courage, and depress that of the Spartans. In these encounters Pelopidas always signalized himself; and in the battle of Tanagra, where the Lacedæmonians were entirely defeated by the Athenians and their allies, Pelopidas had a principal share in the victory, and killed the Spartan general with his own hand. Soon after this, with a body of only 300 Thebans, he entirely routed and dispersed near 1000 Spartans; which was the greatest disgrace the latter had ever known; for till that time, whether in war with the Greeks or barbarians, they had never been overcome by an equal, much less by such an inferior number of troops.

These successes of the Thebans greatly alarmed the
9 Platæa and Thespia razed by the Thebans. Athenians, who continually sought to oppose their growing power. In this opposition they were joined by the Platæans, who on this account became extremely obnoxious to the Thebans, so that they at last came to a resolution to surprise their city. This they accomplished, and entirely destroyed it, together with Thespia, another city extremely well affected to Athens. Soon after this, the Thebans, encouraged by their success, began to think of enlarging their territories, and
10 Account of Epaminondas. of making encroachments on their neighbours, as they saw other states had done before them. This spirit of conquest is said to have been raised by their general Pelopidas; in which he was seconded by Epaminondas, a person who, though like him endowed with all the necessary qualities to make a complete captain or patriot, had till then preferred a private life, and lived in a constant course of virtue and the study of philosophy. He had as yet seldom appeared in public, except to get himself excused from those state employments which were so eagerly courted by others. This, however, had not hindered him from contracting an intimate friendship with Pelopidas, which had been daily improved by the correspondence of their tempers and principles, as well as by that zeal which both displayed for the good of their country; which last had made them, even before this time, appear together in action, and to such advantage, that Epaminondas's merit could be no longer concealed, nor indeed suffer him to continue longer in his beloved retirement: so that he saw himself, at length, deservedly placed at the head of the Theban troops; where he gave such early proofs of his future prowess and abilities as justly gave him the next rank to Pelopidas. Both came now to be considered in the same light, as generals in the field, as governors at home, and as complete statesmen in the council. When the general treaty for restoring peace to Greece came to be proposed by the Athenians, and was upon the point of being executed by the rest of the states, the Thebans refused to agree to it, unless they were comprehended in it under the name of *Bœotians*. This demand was as strenuously opposed by the other contracting powers as insisted on by Epaminondas, who was there as ambassador on the part of the Thebans. Agesilaus, in particular, told him in plain terms, that the Thebans ought to evacuate Bœotia, and leave the cities of it free and independent. To which it was answered by him, that the Lacedæmonians would do well to set them the example, by restoring Messenia to its ancient proprietors, and Laconia to its ancient freedom; for that the pretensions of the city of Thebes to Bœotia were as well founded, at least, as those of Sparta to those two countries. After this he went on, and showed how far Sparta had aggrandized herself at the expence of her neighbours: that peace might be indeed obtained, and upon a solid and lasting footing; but that this could not be otherwise than by bringing all to an equality. This bold though just remonstrance, in which not only Thebes, but Greece in general was concerned, failed not, however, to exasperate the haughty Spartan monarch; and the Athenians, who had till now looked upon the Thebans as dependents either on them or on the Macedonians, were not a little offended to hear their ambassadors talk in such high terms. The result of the conference was, that Agesilaus struck the name of *Thebes* out of the treaty, and declared war against them, about the year 371 B. C. 11 His difference with Agesilaus king of Sparta.

The Thebans were in no small consternation to see themselves engaged in a war with the powerful Spartans, without any ally to assist them; and the rest of the Grecian states having made peace with the latter, began to look upon the ruin of the former as unavoidable. However, they resolved to make the best defence they could; and put their army under the command of Epaminondas, assigning him, at his own request, six others to act as counsellors or assistants. The Theban army consisted at most but of 6000 men, whereas that of the enemy was at least thrice that number; but Epaminondas trusted most to his horse, wherein he had much the advantage both in quality and good management: the rest he endeavoured to supply by the disposition of his men, and the vigour of the attack. He even refused to suffer any to serve under him in the engagement, but such as he knew to be fully resolved to conquer or die. The two armies met at Leuctra, where the Spartans were defeated with great slaughter, as related under that article. 12 The Spartans declare war against Thebes. 13 Are entirely defeated at Leuctra.

The victorious general, desirous to improve this great victory, sent an herald, crowned with garlands, to communicate it in form to the Athenians, in hopes that this would be an effectual means to reunite them to the Theban interest. But it proved quite otherwise. Athens, which now looked upon them with a jealous eye, and had then in view the sovereignty of Greece, chose rather, if they could not wholly obtain it, to share it with Sparta, than to let the Thebans into the whole; and therefore even declined giving their herald audience. However, the Thebans took care to strengthen themselves by alliances; and, besides the Arcadians and Eleans, had got the Phocians, Locrians, Acarnanians, Eubœans, and other states, under their dependence: so that they were now in a condition to act offensively against the Spartans. Accordingly, under pretence of assisting the Arcadians, they entered Peloponnesus with a gallant army, with Epaminondas and Pelopidas at their head. Here they were joined by the Arcadian and other confederate forces; so that the whole amounted to 40,000, 14 The Athenians jealous of the Thebans. 15 The Thebans invade Peloponnesus with a formidable army, but are repulsed.

Thebes. some say 50,000 men, besides great numbers of those who followed the camp, rather for plunder than fighting, and were computed about 20,000 more. The army was divided into four columns, and moved straight towards Sellasia, the place of rendezvous, from which they pursued their journey with fire and sword towards Sparta. But here they were repulsed by Agesilaus, who was then returned to that metropolis.

To repair, in some measure, this disgrace, and at the same time to leave some lasting monument which should redound as much to his glory as to the mortification of the Spartans, Epaminondas left not their territories till he had restored the posterity of the old Messenians to their ancient dominions, out of which they

16 The Messenians restored to their ancient dominions. had been banished near 300 years; rebuilt their capital, and left a strong garrison for its defence. He was, however, nearly cut off in his return by Iphicrates, whom the Athenians had sent with 12,000 men to intercept him; but this last loitered so long at Corinth, that the Thebans had passed the defiles of Cenchreæ, the chief place where he could have obstructed his retreat had he taken possession of it in proper time. Epaminondas continued his march till he came in full view of the city of Corinth. He found the roads choked up with trees, rocks, stones, and every thing that could render them impassable; and the Corinthians well fortified, and resolute on a stout defence. But he came so furiously upon them, notwithstanding all these difficulties, that they abandoned all their entrenchments and

17 The Corinthians defeated. outworks to the Thebans, and fled into the city. Thither these pursued them sword in hand, and made an horrid slaughter of them; insomuch that Corinth must have unavoidably fallen into their hands, had their generals thought fit to pursue these advantages; but whether they were afraid of the Athenians falling upon them, or apprehended some dangerous ambush in a country with which they were but indifferently acquainted, or whether the army was too much weakened through so many fatigues, or, lastly, whether the coldness of the season, it being then the depth of winter, would not permit them to proceed farther, they immediately march-

18 Epaminondas and Pelopidas disgraced at Thebes. ed towards Bœotia. This gave such an advantage to their enemies, that they met with a very mortifying reception at their return to Thebes, where they were both arrested, and seized as state-prisoners, for having presumed to prolong their command four months longer than the time limited by law, which time took in almost the whole of their expedition from their first entrance into Peloponnesus. However, at last, the judges being ashamed to proceed any farther, they were both honourably acquitted.

This prosecution had been chiefly carried on and encouraged by Meneclides a discontented Theban, and a bold and able speaker, who, by his artful calumnies at the trial, had so far prevailed with the judges as to get Epaminondas deprived of the government of Bœotia for a whole year, though he could not gain the same advantage against Pelopidas, who was a greater favourite of the people, as being his senior.

19 War renewed with Sparta. By this delay the Spartans, with much difficulty, had recovered themselves from their great defeat at Leuctra, and settled their affairs in as good a posture as they could; but though they had repulsed the Thebans in Peloponnesus, yet from the exploits they had performed there, especially in the dismembering the whole kingdom of Messenia from them, they had still cause to fear what their forces might do under two such generals; and had accordingly taken due care to strengthen themselves against them, and to provide themselves with a great number of auxiliaries from other states, especially from that of Athens, with whom they had renewed their old treaty, and had agreed that each should have the command five days alternately. Soon after this treaty the Arcadians renewed the war, and took Pallene in Laconia by storm, put the garrison to the sword, and were presently assisted by the Argives and Eleans, and especially by the Thebans, who sent to them 7000 foot, and 500 horse under the command of Epaminondas. This so alarmed the Athenians likewise, that they immediately sent Gobrias with some forces to oppose his passage in good earnest; and he so behaved himself against the Thebans, that they were forced to abandon 20

The Thebans repulsed. Peloponnesus a second time. This ill success gave fresh occasion to the enemies of Epaminondas to blame his conduct in the highest terms, notwithstanding the singular bravery with which he and his troops had forced the pass. Even his friends could not but suspect him of partiality for the Spartans, in not pursuing his advantage over them, and making a greater slaughter of them when he had it in his power; whilst his enemies made it amount to no less than treachery to his country: so that their brave general was once more depriv- 21

Epaminondas degraded. ed of the government of Bœotia, and reduced to the condition of a private man. He did not continue long under this disgrace, before an occasion offered to make his services again of such necessity to the state, as to give him an opportunity to retrieve his fame, and wipe off the stain which his enemies had thrown upon him.

The Thessalians, who had groaned some time under the tyranny of the usurper Alexander, surnamed the 22

Pelopidas seized by Alexander of Pheræ. *Pheræan*, sent an ambassy to Thebes to implore their aid and protection; upon which Pelopidas was immediately sent as ambassador to expostulate with him on their behalf. He was then in Macedon, from whence he took the young prince Philip, afterwards the celebrated monarch, in order to protect and educate him; and, upon his return, marched directly to Pharsalus in Thessaly, in order to punish the treachery of some mercenaries, who had deserted the Thebans in that expedition; but when he came thither, he was surprised to be met by the tyrant at the head of a numerous army before that city, whilst his own was but as an handful of men in comparison of it. However, whether he supposed, or would be thought to do so, that Alexander came thither to justify himself, and answer to the complaints alleged against him, he went, with Ismenias his colleague, to him unarmed and unattended, not doubting but his character as ambassador from so powerful a republic, joined to his own character and authority, would protect them from insult or violence: but he found himself mistaken; for Alexander had no sooner got them into his hands, than he caused them to be seized and sent prisoners to Pheræa. 23

A Theban army sent to rescue him, defeated. The Thebans highly resenting the indignity offered to their ambassadors, sent immediately an army into Thessaly: but the generals were repulsed with great loss by the Pheræan usurper; and it was owing to Epaminondas, who was among them only as a private centinel, that they were not totally cut off. For the Thebans, finding

Thebes. finding themselves in such imminent danger, which they attributed to the incapacity of their generals, had immediately recourse to him, whose valour and experience had been so often tried; and, partly by persuasions and
24 Epaminondas restored. intreaties, and partly by threats, obliged him to take the command. This soon gave a different turn to their affairs, and converted their flight into a safe and regular retreat; for he took the horse and light-armed foot, and placed himself at their head in the rear, and charged the enemy with such vigour and bravery, that he obliged them to desist from their pursuit.

However, as the army had suffered such loss before as not to be able to pursue them in their turn, he was obliged to return with them to Thebes, with their pusillanimous generals; where the latter were fined 12,000 drachms each, and the former was reinstated in the command, and sent with a new reinforcement to repair the late dishonour, and prosecute their revenge. The news of his being in full march on this errand greatly alarmed the tyrant; but Epaminondas, preferring the safety of his imprisoned colleague to all other considerations, forbore pushing hostilities to extremes, for fear of provoking the enemy to wreak all his fury on him: to prevent which, he contented himself for a while hovering about with his army, and now and then with such slight skirmishes as should intimidate the tyrant, and bring him the sooner to make some satisfactory offers. Alexander
25 Rescues Pelopidas. being fully convinced of the superiority of the Theban general, was glad to accept of a truce of 30 days, and to restore Pelopidas and Ismenias to him; upon which he immediately withdrew his forces, and returned with them to Thebes.

By this time Thebes was raised to a sufficient height of reputation and glory to begin to aim in earnest at the sovereignty of Greece. The main obstacle to it was, that the other states grew so jealous of her present greatness, as to enter into the strongest alliances and confederacies to prevent its farther growth; so that not being able now to procure many allies at home, they made no difficulty to seek for them abroad; and the Lacedæmonians, by leading the van, gave them a plausible pretence to follow their steps, and procure an alliance with Persia, which at that time they found was ready to accept of the offers on any terms; the only question was, which of the three states should be preferred, Sparta, Athens, or Thebes. At the same time, the Thebans proposed to their new confederates to send likewise proper deputies to the Persian court, in order to support
26 Success of Pelopidas at the Persian court. their respective interests; which they readily agreed to. These were the Arcadians, Eleans, and Argives; at the head of whose deputation Pelopidas was sent on the behalf of the Thebans; which the Athenians being apprised of, appointed two on their part. These being all arrived at the Persian court, began to pursue each their respective interests; but Pelopidas had by that time gained such credit there, both for his singular address and his extraordinary exploits, that he was distinguished in a particular manner from all the other deputies, and was received by the king with manifest marks of honour and esteem, who freely owned himself convinced that the Thebans were the people on whom he could most safely depend; and after having greatly applauded the equity of his demands, ratified and confirmed them with great readiness, to the no small mortification of the other states. The substance of them was, that the liberties formerly granted to the other towns of Greece should be confirmed, that Messenia, in particular, should continue free and independent on the jurisdiction of Sparta; that the Athenians should lay up their fleet; and that the Thebans should be looked upon as the ancient and hereditary friends of Persia.

The Thebans took advantage of the dissensions which prevailed among the Greeks as a pretence for increasing their forces; and Epaminondas thought it a proper opportunity for his countrymen to make a bold effort to obtain the dominion at sea, as they had obtained it in a great measure at land. He proposed it to them in a public assembly, and encouraged their hopes from the experience of the Lacedæmonians, who in Xerxes's time had, with ten ships only at sea, gained the superiority over the Athenians, who had no fewer than 200; and added, that it would be a disgrace now to Thebes to suffer two such republics to engross the empire of so extensive an element, without putting in at least for their share of it. The people readily came into his proposal, not without extraordinary applause, and immediately ordered 100 galleys to be equipped; and in the mean while sent him to Rhodes, Chios, and Byzantium, to secure those states in their interest, and get what assistance he could from them. His negociations had all the success that could be wished for, notwithstanding the strenuous opposition of the Athenians, and of their admiral Laches, who was sent with a powerful squadron against him. But what more effectually thwarted all his measures, was the work that they found for him at land, and the obliging the Thebans to take part in the quarrels that then reigned among their neighbours: so that whatever projects they had concerted, proved abortive for the present; and the death of Epaminondas, which happened not long after, put an effectual stop to them. Thebes. 27 The Thebans propose to build a fleet.

During the absence of that general, and of his colleague Pelopidas, the Orchomenians, being spirited up by some Theban fugitives, had formed a design to change the Theban government into an aristocracy; and 300 horsemen of the former had been actually sent to put it in execution. Their project, however, was timely discovered by the vigilance of the magistrates, who caused them to be seized, and put immediately to death. They next sent a sufficient force against the city of Orchomenos, with orders to put all the men to death, and to sell the women and children for slaves, which was punctually done; after which they razed that noble city to the ground. Pelopidas was then on his way to Thessaly, at the head of a powerful army, whither he had been sent to assist the Thessalians, who still groaned under the tyranny of Alexander the Pheræan, and had made several brave efforts to recover their liberty, but had been still overpowered by that usurper. Being joined by the Thessalians, he encamped in the face of the enemy, though far superior in number, and consisting of above 20,000 men. A fierce engagement soon ensued, in which both sides fought with uncommon bravery. The place where the battle was fought was called *Cynocephala*, from several little hills on it, between which there ran a large plain. Both sides endeavoured at first to post themselves on these eminences with their foot, whilst Pelopidas ordered his cavalry to charge that of the enemy below; which they did with such success, that they soon put them to the rout, and pursued them over the plain. This obliged the tyrant to gain the tops of the hills, where he greatly 28 The city of Orchomenos razed. 29 Pelopidas marches against the Thessalian tyrant.

Thebes. greatly annoyed the Thessalians that endeavoured to force those ascents; so that Pelopidas was obliged to give over his pursuit to come to their relief. This immediately inspired the Thessalians with fresh courage, who began again to charge the enemy at several onsets; and soon threw them into such disorder, that they were forced to give way. Pelopidas no sooner perceived the advantage, than he began to look about for Alexander, with a design of engaging him. Having found him out as he was commanding his right wing, and endeavouring to rally his men, he moved directly to him; and being got near enough to be heard by him, challenged him to decide the battle by single combat with him. Alexander, instead of accepting the offer, turned about, and with all the speed he could ran to screen himself amongst his guards. Upon this Pelopidas charged him with such furious speed, that he obliged him to retire farther, and shelter himself within the thickest ranks; the sight of which made him attack with fresh vigour, and fight more desperately against him. He tried in vain several times to break through their ranks to reach him, cutting down great numbers of those that came forward to oppose him: his eagerness at length exposed him so far to the darts that were shot at him at a distance, that some of them went quite through his armour, and gave him a desperate wound or two, while the rest advanced and stabbed him in the breast with their spears.

30 Is killed.

It is scarcely possible for words to express the grief and despair which not only his brave Thebans, but likewise the Thessalians and other allies, showed at the sight of their slain general: some of the latter, who had perceived the danger he was exposed to, came down the hill with all possible speed to his relief; but when they perceived that they were come too late to save him, both they and the rest of the little army thought on nothing now but to revenge his death. They rallied accordingly both horse and foot, as quick as possible, and began to charge the enemy afresh, and with such desperate fury, that they at length gained a complete victory over them, and killed above 3000 of them in the pursuit, besides a much greater number which they had slain on the field of battle, though they still looked upon all these advantages as vastly too small to compensate the loss of their brave general.

31 Alexander defeated,

The news of his death had no sooner reached Thebes, than the whole city was seen in as deep a mourning as his army. However, they sent a reinforcement to it of 7000 foot and 700 horse, as well to revenge the death of that general, as to improve the victory he had gained over the enemy; by the help of which they fell so furiously on them, that they quickly broke and totally defeated the shattered remains of Alexander's army. Hereupon he was forced to sue for peace, and to accept it on such conditions as the conquerors thought fit to impose. He was at length dispatched in his bed by his wife Thebe, assisted by her brothers, about seven years after his defeat. His body was afterwards dragged along the streets, trodden under foot, and left a prey to the dogs.

32 and at last murdered.

33 Ambition of the Thebans.

All this while the Thebans were watching to improve every commotion that happened, every success they met with, to the forwarding of their then reigning and favourite project, of increasing their power above all the rest, and in their turn to give laws to Greece. Their late success in Thessaly, and the rupture between the Arcadians and Mantineans at the same time, about some consecrated money which the former had taken out of the temple of Olympias to pay their troops employed against the Eleans, and which the latter called a downright sacrilege, besides other discords that reigned in the other states of Greece, gave fresh encouragement to Thebes to set up for arbitress in those disputes; and so much the more, as those who had embezzled the sacred money, and wanted rather to embroil matters than to have them brought to light, sent that republic word that the Arcadians were just upon the point of revolting to the Spartans, and advised them to come and put an immediate stop to it. At the same time they dispatched some private directions to a Theban officer at Tegea, to apprehend several of their own people as disturbers of the peace. This was accordingly done, and several eminent persons were confined as prisoners of state: they were soon after discharged, and loud complaints were made against such arbitrary and unjust proceedings. The officer was accused before the Theban senate of having intermeddled in their affairs, and endeavoured to interrupt the good correspondence between the two states. It was even insisted on by some of the Tegeans, that he should be indicted and proceeded against by his principals; whilst the more moderate sort, who foresaw the consequences that were likely to attend such appeals, and that it would infallibly bring the Thebans upon them, loudly protested against their marching into their territories, and did all they could to prevent it. The Thebans, however, were become too powerful and ambitious to miss so fair an opportunity of getting once more footing in Peloponnesus, as they had long ago premeditated; and Epaminondas was so far from making a secret of their design, that he told the Arcadian deputies in justification of it, that as it was on their account that the Thebans engaged in the war, they had acted treacherously with them in making peace with Athens without their consent: however, that when he had joined his army on his march into Peloponnesus to assist his friends, he would soon see what proofs the Arcadians would give of their fidelity. This speech did not fail to alarm them greatly; especially as it was spoken in such a magisterial style and threatening tone. Even those who were best affected to the Thebans could not forbear expressing their dislike of it; and all that had the welfare of Peloponnesus at heart readily agreed with the Mantineans, that there was no time to be lost to use all proper means to prevent the impending storm.

34 Epaminondas displeases the states of Greece.

Athens and Sparta were accordingly applied to, and were easily prevailed upon to assist the Mantineans, and to come into a strict confederacy against the Thebans; and to prevent all disputes about the command of the army, it was agreed that each state should have it in its own territories; which plainly shows how terrified they all were at the apprehension of a fresh invasion of the Thebans: for this was a point which neither the Spartans nor Athenians would have so readily given up to the Arcadians, though these had formerly as strenuously insisted upon it, even when they were almost reduced to the last extremity, and had never been able to obtain it till now. But Epaminondas was then in full march at the head of his Bœotian troops, with some Eubœan auxiliaries, and a body of stout Thessalian horse; and was moreover to be joined by the Messenians, Argives, and several

35 A combination against Thebes.

Thebes.

several other nations, as soon as he had entered Peloponnesus. The confederate army against him had ordered their rendezvous at Mantinea, the place which they naturally concluded would be first attacked, as being the chief seat of those who had revolted from the Thebans. But whilst they were securing themselves on that side, Epaminondas, who wisely considered how far this confederacy and expedition must have drained the city of Sparta of its main strength, broke up privately from Nemæa, where he had lain for some time encamped, and marched all that night with a design to have surprised that important capital: but, his project being timely discovered, the vigilant king took care to disconcert it; so that, though the Theban general made several vigorous assaults on that city, he was so stoutly repulsed, and the Spartans behaved with such intrepid valour, that he was forced to retire and turn his thoughts against Mantinea, which he judged by this time to have been quite defenceless. He judged rightly indeed; for the place was not only drained of its troops, but likewise of its inhabitants, who took that opportunity, whilst the scene of war was in Lacedæmon, to gather in their harvest, and were scattered all over the country; so that he would not have met with any difficulty in gaining the town, had not the Athenian auxiliaries come unexpectedly to its relief, and given him a fresh repulse.

36 Epaminondas makes an unsuccessful attempt on Sparta,

37 and on Mantinea.

These two last defeats greatly exasperated the Theban general, who had never before experienced such disasters, and could not but foresee that they would not only lessen his reputation with his allies, but, if not timely retrieved, would sully the glory of all his former exploits. What added to his present difficulties was, that the time allotted him for his expedition was almost expired; so that he had but a short space left to undertake some brave achievement, which might recover his and his country's honour, and keep up the spirits of his auxiliaries, and those under his protection. He was moreover got very far into his enemy's country, and saw plain enough how narrowly they watched all his motions, and how well prepared they were to oppose him whatever attempt he resolved upon, whether to attack them or to retreat. Under all these difficulties, he rightly considered, that he must immediately resolve upon a decisive battle; in which, if his pristine fortune followed him, he might at once retrieve his affairs, and make himself master of Peloponnesus; or, if that failed him, as it lately had done, fall honourably in the attempt. In this engagement Epaminondas made the wisest disposition of his troops, attacked and fought with the most intrepid courage and conduct, and had opened himself a way through the Spartan phalanxes, thrown them into the utmost confusion, and made a terrible slaughter of them, insomuch that the field of battle was covered with their wounded and slain, when, in the heat of the fight, having ventured himself too far in order to give them a total overthrow, the enemy rallied again, pouring with their whole fury three volleys of darts at him, some of which he drew out and returned to them, till at length, being covered with wounds, and weakened with the loss of so much blood, he received a mortal wound from a javelin, and was with great difficulty rescued from the enemy by his brave Thebans, and brought alive, though speechless, into his tent. As soon as he had recovered himself, he asked his friends that were about him what was become of his shield; and being told that it was safe, he beckoned to have it brought to him, and kissed it. He next inquired which side had gained the victory; and being answered, The Thebans; he replied, Then all is well: and upon observing some of his friends bewail his untimely death, and leaving no children behind him, he is said to have answered, Yes; I have left two fair daughters, the victory of Leuctra, and this of Mantinea, to perpetuate my memory. Soon after this, upon drawing the point of the javelin out of his body, he expired.

38 Battle of Mantinea.

39 Epaminondas killed.

The consequence of this great general's fall, and of this bloody fight in which neither party could boast any great advantage over the other, but a great loss of men on both sides, insomuch that Xenophon makes it a drawn battle, was, that both parties agreed on a cessation of arms, and parted, as it were by consent, to take care of their wounded and slain. The Thebans indeed thus far gained the greater share of glory, that they renewed the fight, and after a most desperate contest, gained the victory over those Spartans that opposed them, and rescued the body of their dying general out of their hands. However, an effectual end was put to this bloody war, and a general peace agreed on by all but Sparta; who refused it only because the Messenians were included in it. But as to the Thebans, they had no great reason to boast of this dear-bought victory, since their power and glory began to decline from that very time; so that it may be truly said, that it rose and set with their great general. 40

40 Peace concluded.

On the death of Epaminondas, the Thebans relapsed into their former state of inactivity and indolence; and at last having ventured to oppose Alexander the Great, their city was taken, and the inhabitants slaughtered for several hours, after which the buildings were destroyed. It was rebuilt by Casander, but never afterwards made any considerable figure among the states of Greece. About the year 146 B. C. it fell under the power of the Romans, under which it continued till the extinction of their empire by the Turks. It is now called *Thive*, and, according to Dr Clarke, is about two and a half English miles in circumference. It contains about 300 houses, and many interesting antiquities. The present population live chiefly within what was anciently the citadel. The circuit of the walls can yet be traced, and many parts of them are still standing. There are two mosques in Thebes, and a great many Greek churches. It is seated between two small rivers, at the south-west side of a large plain, in E. Long. 23. 40. N. Lat. 38. 17.

41 State of Thebes to the present time.

THEBES, in Egypt, one of the most renowned cities of the ancient world. It was also called *Diospolis*, or the city of Jupiter, and was built, according to some, by Osiris, according to others by Busiris. Its length, in Strabo's time, was 80 furlongs, or ten miles; but this was nothing in comparison of its ancient extent, before it was ruined by Cambyses, which, we are told was no less than 420 stadia, or 52 miles and an half. The wealth of this city was so great, that, after it had been plundered by the Persians, what was found, on burning the remains of the pillage, amounted to above 300 talents of gold and 2300 of silver.

Ancient Universal History, vol. i.

Mr Bruce visited the ruins of this celebrated city; but informs us that nothing now remains except four temples, and these neither so entire nor magnificent as some others at a place called *Dendera*. Thebes has been

Thebes, Theft. been celebrated by Homer for its hundred gates; but Mr Bruce informs us, that no vestiges of these are now remaining, neither can we discover the foundation of any wall it ever had; "and as for the horsemen and chariots it is said to have sent out, all the Thebaid sown with wheat would not have maintained one half of them. Thebes, at least the ruins of the temples called *Medinet Tabu*, are built in a long stretch of about a mile broad, most parsimoniously chosen at the sandy foot of the mountains. The *Horti Pensiles*, or hanging gardens, were surely formed upon the sides of these hills, then supplied with water by mechanical devices. The utmost is done to spare the plain, and with great reason; for all the space of ground this ancient city has had to maintain its myriads of horses and men, is a plain of three quarters of a mile broad between the town and the river, upon which plain the water rises to the height of four and five feet. All this pretended populousness of ancient Thebes I therefore believe to be fabulous."

Bruce's Travels.

Mr Bruce, after examining the ground on which Thebes is supposed to have stood, thinks that it had no walls, and that consequently Homer's story of its having an hundred gates is misunderstood. The mountains of the Thebaid stand close behind the town, not in a ridge, but standing single, so that you can go round each of them. A hundred of these are said to be hollowed out for sepulchres and other purposes. These, he thinks, were the hundred gates of Homer; in proof of this they are still called by the natives *Beeban el Meluke*, "the ports or gates of the kings."

All that is said of Thebes by poets or historians after the days of Homer is meant of Diospolis, which was built by the Greeks long after Thebes was destroyed, as its name testifies; though Diodorus says it was built by Busiris. It was on the east side of the Nile, whereas ancient Thebes was on the west, though both are considered as one city. Splendid descriptions of the antiquities of Thebes were published in 1802 by Denon, and several additions have been made by late travellers.

THEFT, or Simple Larceny, is "the felonious taking and carrying away of the personal goods of another." This offence certainly commenced then, whenever it was, that the bounds of property, or laws of *meum* and *tuum*, were established. How far such an offence can exist in a state of nature, where all things are held to be common, is a question that may be solved with very little difficulty. The disturbance of any individual in the occupation of what he has seized to his present use, seems to be the only offence of this kind incident to such a state. But, unquestionably, in social communities, when property is established, any violation of that property is subject to be punished by the laws of society; though how far that punishment should extend is matter of considerable doubt.

By the Jewish law it was only punished with a pecuniary fine, and satisfaction to the party injured; and, in the civil law, till some very late constitutions, we never find the punishment capital. The laws of Draco at Athens punished it with death: but his laws were said to be written with blood; and Solon afterwards changed the penalty to a pecuniary mulct. And so the Attic law in general continued; except that once, in a time of dearth, it was made capital to break into a garden and steal figs: but this law, and the informers against the offence, grew so odious, that from them all malicious informers were styled *sycophants*; a name which we have much perverted from its original meaning. From these examples, as well as the reason of the thing, many learned and scrupulous men have questioned the propriety, if not lawfulness, of inflicting capital punishment for simple theft. And certainly the natural punishment for injuries to property seems to be the loss of the offender's own property; which ought to be universally the case, were all men's fortunes equal. But as those who have no property themselves are generally the most ready to attack the property of others, it has been found necessary, instead of a pecuniary, to substitute a corporal punishment; yet how far this corporal punishment ought to extend, is what has occasioned the doubt. Sir Thomas More and the Marquis Beccaria, at the distance of more than two centuries, have very sensibly proposed that kind of corporal punishment which approaches the nearest to a pecuniary satisfaction, viz. a temporary imprisonment, with an obligation to labour, first for the party robbed, and afterwards for the public, in works of the most slavish kind; in order to oblige the offender to repair, by his industry and diligence, the depredations he had committed upon private property and public order. But, notwithstanding all the remonstrances of speculative politicians and moralists, the punishment of theft still continues throughout the greatest part of Europe to be capital: and Puffendorf, together with Sir Matthew Hale, are of opinion that this must always be referred to the prudence of the legislature: who are to judge, say they, when crimes are become so enormous as to require such sanguinary restrictions. Yet both these writers agree, that such punishment should be cautiously inflicted, and never without the utmost necessity.

The Anglo-Saxon laws nominally punished theft with death, if above the value of twelvepence: but the criminal was permitted to redeem his life by a pecuniary ransom; as, among their ancestors the Germans, by a stated number of cattle. But in the 9th year of Henry I. this power of redemption was taken away, and all persons guilty of larceny above the value of twelvepence were directed to be hanged; which law continues in force to this day. For though the inferior species of theft, or petit larceny, is only punished by whipping at common law, or (by stat. 4 Geo. I. c. 11.) may be extended to transportation for seven years, as is also expressly directed in the case of the Plate-glass Company; yet the punishment of grand larceny, or the stealing above the value of twelvepence (which sum was the standard in the time of King Athelstan, 800 years ago), is at common law regularly death: which, considering the great intermediate alteration in the price or denomination of money, is undoubtedly a very rigorous constitution: and made Sir Henry Spelman (above a century since, when money was at twice its present rate) complain, that while every thing else was risen in its nominal value, and become dearer, the life of man had continually grown cheaper. It is true, that the mercy of juries will often make them strain a point, and bring in larceny to be under the value of twelvepence, when it is really of much greater value: but this, though evidently justifiable and proper when it only reduces the present nominal value of money to the ancient standard, is otherwise a kind of pious perjury, and does not at all excuse our common law in this respect from the imputation of severity,

verity, but rather strongly confesses the charge. It is likewise true, that by the merciful extensions of the benefit of clergy by our modern statute-law, a person who commits a simple larceny to the value of thirteen pence or thirteen hundred pounds, though guilty of a capital offence, shall be excused the pains of death; but this is only for the first offence. And in many cases of simple larceny the benefit of clergy is taken away by statute: as from horse-stealing in the principals and accessories both *before* and *after* the fact; theft by great and notorious thieves in Northumberland and Cumberland; taking woollen cloth from off the tenters, or linens, fustians, calicoes, or cotton goods, from the place of manufacture (which extends, in the last case, to aiders, assisters, procurers, buyers, and receivers); feloniously driving away, or otherwise stealing one or more sheep or other cattle specified in the acts, or killing them with intent to steal the whole or any part of the carcase, or aiding or assisting therein; thefts on navigable rivers above the value of forty shillings, or being present, aiding and assisting thereat; plundering vessels, in distress, or that have suffered shipwreck; stealing letters sent by the post; and also stealing deer, hares, and conies, under the peculiar circumstances mentioned in the Waltham black act. Which additional severity is owing to the great malice and mischief of the theft in some of these instances; and in others, to the difficulties men would otherwise lie under to preserve those goods, which are so easily carried off. Upon which last principle the Roman law punished more severely than other thieves the *Abigei* or stealers of cattle, and the *Balnearii* or such as stole the clothes of persons who were washing in the public baths; both which constitutions seem to be borrowed from the laws of Athens. And so, too, the ancient Goths punished with unrelenting severity thefts of cattle, or of corn that was reaped and left in the field: such kind of property (which no human industry can sufficiently guard) being esteemed under the peculiar custody of heaven.

Theft-Bote (from the Saxon *theof*, i. e. *fur*, and *bote*, *compensatio*), is the receiving of a man's goods again from a thief, after stolen, or other amends not to prosecute the felon, and to the intent the thief may escape; which is an offence punishable with fine and imprisonment, &c.

THELIGONUM, a genus of plants belonging to the class monœcia, and order of polyandria; and in the natural system ranging under the 53d order, *Scabridæ*. See Botany *Index*.

THEME, denotes the subject of an exercise for young students to write or compose on.

THEMISON, a physician of Laodicea, a disciple of Asclepiades. He founded the methodic sect, with a view to the more easily teaching and practising the art of medicine. (See Medicine, N° 37.). Themison gave the first account of diacodium, which was prepared of the juice and decoction of poppy-heads and honey.

THEMISTIUS, an ancient Greek orator and philosopher who flourished in the 4th century, was a native of Paphlagonia. He had great interest and favour with the emperors in his time, and though a heathen, was of a very tolerating spirit. He taught for many years at Constantinople, of which city he was made præfect by Julian and Theodosius; and lived to a great age. More than 30 of his orations are still extant, beside commentaries on several parts of Aristotle's works.

THEMISTOCLES, the renowned Athenian admiral, general, and patriot, who gained the battle of Salamis against the Persians. Being banished his country by his ungrateful fellow-citizens, he fled to Artaxerxes king of Persia: but, in order to avoid taking up arms against his country, he slew himself, 464 B. C. See Attica, N° 76, *et seq.*

THEOBALD, Lewis, the son of an attorney at Sittingbourn in Kent, was a well-known writer and critic in the early part of the 18th century. He engaged in a paper called the *Censor*, published in Mist's Journal, wherein, by delivering his opinions with too little reserve concerning some eminent wits, he exposed himself to their resentment. Upon the publication of Pope's Homer, he praised it in terms of extravagant admiration, yet afterwards thought proper to abuse it as earnestly; for which Pope at first made him the hero of his Dunciad, though he afterwards laid him aside for another. Mr Theobald not only exposed himself to the lashes of Pope, but waged war with Mr Dennis, who treated him more roughly, though with less satire. He nevertheless published an edition of Shakespeare, in which he corrected, with great pains and ingenuity, many faults that had crept into that poet's writings. This edition is still in great esteem; being in general preferred to those published by Pope, Warburton, and Hanmer. He also wrote some plays, and translated others from the ancients.

THEOBROMA, a genus of plants belonging to the class of polyadelphia, and order of pentandria; and in the natural system ranging under the 37th order, *Columniferæ*. See Botany *Index*.

THEOCRACY, in matters of government, a state governed by the immediate direction of God alone: such was the ancient government of the Jews before the time of Saul.

THEOCRITUS, the father of pastoral poetry, was born at Syracuse in Sicily. Two of his poems ascertain his age; one addressed to Hiero king of Syracuse, who began his reign about 275 years before Christ; and the other to Ptolemy Philadelphus king of Egypt. Hiero, though a prince distinguished in arms and political wisdom, does not seem to have been a patron of learning. This is supposed to have given birth to the 16th Idyllium. From Syracuse Theocritus went to Alexandria, where he seems to have found a munificent patron in Ptolemy Philadelphus, if we may judge from the panegyric which he composed on that prince (the 17th Idyllium). It has been said that Theocritus was strangled by Hiero, but we have not found evidence of this.

The compositions of this poet are distinguished, among the ancients, by the name of *Idylliums*, in order to express the smallness and variety of their natures: they would now be called *Miscellanies*, or *Poems on several Occasions*. The first nine and the eleventh are confessed to be true pastorals, and hence Theocritus has usually passed for nothing more than a pastoral poet; yet he is manifestly robbed of a great part of his fame, if his other poems have not their proper laurels. For though the greater part of his Idylliums cannot be called the songs of shepherds, yet they have certainly their respective merits. His pastorals ought to be considered as the foundation of his credit; upon this claim he will be admitted for the finisher as well as the inventor of his art, and will be acknowledged to have excelled all his imitators as much as originals usually do their copies.

The

The works of this poet were first published in folio by Aldus Manutius at Venice in 1495. A more elegant and correct edition was printed by Henry Stephens at Paris in 1566. An edition was published at Leipsic in 1765, with valuable notes by the learned Reiske. But what will most highly gratify the admirers of pastoral poetry, is an edition published in 1770, 2 vols. 4to, by Mr Thomas Wharton. It is accompanied by the scholia of the best editors, and the different readings of 15 MSS.

THEODOLITE, a mathematical instrument for measuring heights and distances. See MENSURATION and SURVEYING.

THEODORE, king of Corsica, Baron Nieuhoff in the county of La Marc in Westphalia. He had his education in the French service, and afterwards went to Spain, where he received some marks of regard from the duke of Riperda and Cardinal Alberoni; but being of an unsettled disposition, he quited Spain, and travelled into Italy, England, and Holland, in search of new adventures. He at last fixed his attention on Corsica, and formed the scheme of rendering himself sovereign of that island. He was a man of abilities and address; and having fully informed himself of every thing relating to Corsica, went to Tunis, where he fell upon means to procure some money and arms; and then went to Leghorn, from whence he wrote a letter to the Corsican chiefs Giafferi and Paoli, offering considerable assistance to the nation if they would elect him as their sovereign. This letter was consigned to Count Domenico Rivarola, who acted as Corsican plenipotentiary in Tuscany, and he gave for answer, that if Theodore brought the assistance he promised to the Corsicans, they would very willingly make him king.

Upon this he, without loss of time, set sail, and landed at Tavagna in the spring of the year 1736. He was a man of a very stately appearance, and the Turkish dress he wore added to the dignity of his mien. He had a few attendants with him; and his manners were so engaging, and his offers so plausible, that he was proclaimed king of Corsica before Count Rivarola's dispatches arrived to inform the chiefs of the terms upon which he had agreed. He brought with him about 1000 zequins of Tunis, besides some arms and ammunition, and made magnificent promises of foreign assistance; whence the Corsicans, who were glad of any support, willingly gave into his schemes. Theodore instantly assumed every mark of royal dignity. He had his guards and his officers of state; he conferred titles of honour, and struck money both of silver and copper. The silver pieces were few in number, and can now hardly be met with; the copper coins have on one side T. R. that is, "Theodorus Rex," with a double branch crossed, and round it this inscription, PRO BONO PUBLICO RE. CO. that is, "For the public good of the kingdom of Corsica: on the other side is the value of the piece; *Cinque solidi*, or five sous.

The Genoese were not a little confounded with this unexpected adventurer. They published a violent manifesto against Theodore, treating him with great contempt; but at the same time showing they were alarmed at his appearance. Theodore replied in a manifesto, with all the calmness and dignity of a monarch; but after being about eight months in Corsica, perceiving that the people began to cool in their affections towards him, he assembled his chiefs, and declared he would keep them no longer in a state of uncertainty, being determined to seek in person the support he so long expected. He settled an administration during his absence, recommended unity in the strongest terms, and left the island with reciprocal assurances of fidelity and affection. He went to Holland, where he was so successful as to obtain credit from several rich merchants, particularly Jews, who trusted him with cannon and other warlike stores to a great value, under the charge of a supercargo. With these he returned to Corsica in 1739; but by this time the French, as auxiliaries to the Genoese, had become so powerful in the island, that though Theodore threw in his supply of warlike stores, he did not incline to venture his person, the Genoese having set a high price on his head. He therefore again departed; and after many unavailing attempts to recover his crown, at length chose for retirement a country where he might enjoy the participation of that liberty which he had so vainly endeavoured to give his Corsicans; but his situation in England by degrees grew wretched, and he was reduced so low as to be several years before his death a prisoner for debt in the King's Bench. At length, to the honour of some gentlemen of rank, a charitable contribution was set on foot for him in the year 1753. Mr Boswell observes, that Mr Horace Walpole generously exerted himself for the unhappy Theodore, and wrote a paper in *The World* with great elegance and humour, soliciting a contribution for the unhappy monarch in distress, to be paid to Mr Robert Dodsley bookseller, as lord high treasurer. This brought him a very handsome sum, and he was set at liberty. That gentleman adds, that Mr Walpole has the original deed, by which Theodore made over the kingdom of Corsica in security to his creditors, and that he has also the great seal of the kingdom. Theodore died in 1756, and was buried in St Ann's churchyard, Westminster; where, in 1757, a simple unadorned monument of marble was erected to his memory by a gentleman, with an inscription, which, after mentioning some of the above particulars, concludes with the following lines:

> The grave, great teacher, to a level brings
> Heroes and beggars, galley-slaves and kings:
> But Theodore this moral learn'd ere dead,
> Fate pour'd its lesson on his living head,
> Bestow'd a kingdom and deny'd him bread.

THEODORET, bishop of St Cyricus in Syria, in the 4th century, and one of the most learned fathers of the church, was born in the year 386, and was the disciple of Theodorus Mopsuestia and St John Chrysostom. Having received holy orders, he was with difficulty persuaded to accept of the bishopric of St Cyricus, about the year 420. He discovered great frugality in the expences of his table, dress, and furniture, but spent considerable sums in improving and adorning the city of Cyricus. He erected two large bridges, public baths, fountains, and aqueducts, and laboured with great zeal and success in his diocese. Yet his zeal was not confined to his own church: he went to preach at Antioch and the neighbouring towns; where he became admired for his eloquence and learning, and had the happiness to convert multitudes of people. He wrote in favour of John of Antioch and the Nestorians, against Cyril's Twelve Anathemas: he afterwards attacked the opinions of Nestorius, and was deposed in the synod held by the Eutychians,

Eutychians at Ephesus; but was again restored by the general council of Chalcedon, in which he was present, in 451. It is thought that he died soon after; though others say that he lived till the year 457. There are still extant Theodoret's excellent Commentary on St Paul's Epistles, and on several other books of the Holy Scriptures. 2. His Ecclesiastical History from the time of Arius to Theodosius the Younger. 3. The History of the famous Anchorites of his time. 4. Epistles. 5. Discourses on Providence. And, 6. An excellent treatise against the Pagans, entitled, *De Curandis Græcorum Affectibus*; and other works. The best edition of all which is that of Father Sirmond in Greek and Latin, in 4 vols folio.

THEODOSIUS I. called the *Great*, was a native of Spain. The valour he had shown, and the great services he had done to the empire, made Gratian, when attacked by the Goths and Germans, to admit him as a partner in the government. He received the purple in 379, aged 43. See CONSTANTINOPLE, N° 77—88.

THEOGONY, from Θεος, *God*, and γονη, "seed, offspring," that branch of the heathen theology, which taught the genealogy of their gods.

Hesiod gives us the ancient theogony in a poem under that title. Among the most ancient writers, Dr Burne observes that theogony and cosmogony signified the same thing. In effect, the generation of the gods of the ancient Persians, fire, water, and earth, is apparently no other than that of the primary elements.

THEOGNIS, an ancient Greek poet of Megara in Achaia, flourished about the 59th Olympiad, 144 B. C. We have a moral work of his extant, containing a summary of precepts and reflections, usually found in the collections of the Greek minor poets.

THEOLOGY

1 Definition. IS a Greek word (θεολογια), and signifies that science which treats of the being and attributes of God, his relations to us, the dispensations of his providence, his will with respect to our actions, and his purposes with respect to our end. The word was first used to denote the fables of those poets and philosophers who wrote of the genealogy and exploits of the gods of Greece. It was afterwards adopted by the earliest writers of the Christian church, who styled the author of the Apocalypse, by way of eminence, ὁ θεολογος, *the Divine*.

Although every pagan nation of antiquity had some tutelary deities peculiar to itself, they may yet be considered as having all had the same theology, since an intercommunity of gods was universally admitted, and the heavenly bodies were adored as the *dii majorum gentium* over the whole earth. This being the case, we are happily relieved from treating, in the same article, of the truths of Christianity and the fictions of paganism, as we have elsewhere traced idolatry from its source, and shown by what means "the foolish hearts of men became so darkened that they changed the glory of the incorruptible God into an image made like to corruptible man, and to birds, and four-footed beasts, and creeping things." See POLYTHEISM.

The absurdities and inconsistency of the pretended revelation of the Arabian impostor have been sufficiently exposed under the words ALCORAN and MAHOMETANISM; so that the only theology of which we have to

2 Christian theology, treat at present is the *Christian* theology, which comprehends that which is commonly called *natural*, and that which is *revealed* in the scriptures of the Old and New Testaments. These taken together compose a body of science so important, that in comparison with it all other sciences sink into insignificance; for without a competent knowledge of the attributes of God, of the several relations in which he stands to us, and of the ends for which we were created, it is obvious that we must wander through life like men groping in the dark, strangers to the road on which we are travelling, as well as to the fate awaiting us at the end of our journey.

But if this knowledge be necessary to all Christians, it is doubly so to those who are appointed to feed the flock of Christ, and to teach the ignorant what they are to believe, and what to do, in order to work out their own salvation. The wisdom and piety of our ancestors have accordingly founded professorships of theology in all our universities, where the principles of our religion are taught in a systematic and scientific manner; and the church has ordained, that no man shall be admitted to the office of a preacher of the gospel who has not attended a regular course of such theological lectures. 3 to be studied carefully by those intended for the service of the church.

It must not, however, be supposed, that, by merely listening to a course of lectures however able, any man will become an accomplished divine. The principles of this science are to be found only in the word and works of God; and he who would extract them pure and unsophisticated, must dig for them himself in that exhaustless mine. To fit a man for this important investigation, much previous knowledge is requisite. He must study the works of God scientifically before he can perceive the full force of that testimony which they bear to the power, the wisdom, and the goodness of their author. Hence the necessity of a general acquaintance with the physical and mathematical sciences before a man enter on the proper study of theology, for he will not otherwise obtain just and enlarged conceptions of the God of the universe. See PHYSICS, N° 115. 4 Previous knowledge requisite for the prosecution of this study.

But an acquaintance with the physical and mathematical sciences is not alone a sufficient preparation for the study of theology. Indeed it is possible for a man to devote himself so wholly to any of these sciences, as to make it counteract the only purposes for which it can be valuable to the divine; for he who is constantly immersed in matter, is apt to suspect that there is no other substance; and he who is habituated to the routine of geometrical demonstration, becomes in time incapable of reasoning at large, and estimating the force of the various degrees of moral evidence. To avert these disagreeable consequences, every man, before he enters on the study of that science which is the subject of the present article, should make himself acquainted with the principles of logic, the several powers of the human mind, and the different sources of evidence; in doing which he will find the greatest assistance from Bacon's *Novum Organum*, Introduction. *ganum*, Locke's *Essay on the Human Understanding*, Reid's *Essays on the Intellectual and Active Powers of Man*, and Tatham's *Chart and Scale of Truth*. These works will teach him to think justly, and guard him against a thousand errors, which those who have not laid such a foundation are apt to embrace as the truths of God.

The man who proposes to study theology ought to have it in view as the ultimate end of his labours, to impart to others that knowledge which he may procure for himself. "Amongst the many marks which distinguish the *Christian* philosopher from the *Pagan*, this (says a learned writer†) is one of the most striking— the *Pagan* sought knowledge in a selfish way, to secret it for his own use; the *Christian* seeks it with the generous purpose (first in view, though last in execution) to impart it to others. The Pagan philosopher, therefore, having cultivated the *art of thinking*, proceeds to that of *speaking*, in order to display his vanity in the dexterous use of deceit. On the other hand, the *Christian philosopher* cultivates the *art of speaking*, for the sole purpose of disseminating the truth in his office of preacher of the gospel."

† *Warburton.*

As every man, before he enters on the proper study of theology, receives, at least in this country, the rudiments of a liberal education, it may perhaps be superfluous to mention here any books as peculiarly proper to teach him the art of speaking: we cannot however forbear to recommend to our student the attentive perusal of Quintilian's *Institutions*, and Dr Blair's *Lectures on Rhetoric and the Belles Lettres*. A familiar acquaintance with these works will enable him, if he be endowed by nature with talents fit for the office in which he proposes to engage, to express his thoughts with correctness and elegance; "without which, it has been well observed, that science, especially in a clergyman, is but learned lumber, a burden to the owner, and a nuisance to every body else."

No man can proceed thus far in the pursuits of general science without having been at least initiated in the learned languages; but he who intends to make theology his profession should devote himself more particularly to the study of Greek and Hebrew, because in these tongues the original scriptures are written. He who is incapable of consulting the original scriptures, must rest his faith, not on the sure foundation of the word of God, but on the credit of fallible translators; and if he be at any time called on to vindicate revelation against the scoffs of infidelity, he will have to struggle with many difficulties which are easily solved by him who is master of the original tongues.

5
Cautions to be observed in attending the lectures of a professor.

The student having laid in this stock of preparatory knowledge, is now qualified to attend with advantage the theological lectures of a learned professor; but in doing this, he should be very careful neither to admit nor reject any thing on the bare authority of his master. Right principles in theology are of the utmost importance, and can rest on no authority inferior to that of the word of God. On this account we have long been of opinion, that a professor cannot render his pupils so much service by a systematical course of lectures, as by directing their studies, and pointing out the road in which they may themselves arrive in the shortest time at the genuine sense of the sacred scriptures. In this opinion we have the honour to agree with the ablest lecturer ‡ in theology that we have ever heard. The authors of all systems are more or less prejudiced in behalf of some particular and artificial mode of faith. He, therefore, who begins with the study of them, and afterwards proceeds to the sacred volume, sees with a jaundiced eye every text supporting the peculiar tenets of his first master, and acts as absurd a part as he who tries not the gold by the coppel, but the coppel by the gold. Before our young divine, therefore, sit down to the serious perusal of any one of those *institutes* or *bodies of theology* which abound in all languages, and even before he read that which the nature of our work compels us to lay before him, we beg leave to recommend to his consideration the following

‡ *The late Dr Campbell of Aberdeen.*

Preliminary Directions for the Study of Theology.

6
Christian theology divided into two great parts.

Christian theology is divided into two great parts, *natural* and *revealed;* the former comprehending that which may be known of God from the creation of the world, even his eternal power and Godhead; the latter, that which is discovered to man nowhere but in the sacred volume of the Old and New Testaments.

7
First principles of theology communicated.

Concerning the extent of natural theology many opinions have been formed, whilst some have contended that there is no such thing. Into these disputes we mean not at present to enter. We believe that one of them could have had no existence among sober and enlightened men, had the contending parties been at due pains to define with accuracy the terms which they used. Whatever be the origin of religion, which we have endeavoured to ascertain elsewhere (see Religion, N°6—17.), it is obvious, that no man can receive a written book as the word of God till he be convinced by some other means that God exists, and that he is a Being of power, wisdom, and goodness, who watches over the conduct of his creature man. If the progenitor of the human race was instructed in the principles of religion by the Author of his being (a fact of which it is difficult to conceive how a consistent theist can entertain a doubt), he might communicate to his children, by natural means, much of that knowledge which he himself could not have discovered had he not been supernaturally enlightened. Between illustrating or proving a truth which is already talked of, and making a discovery of what is wholly unknown, every one perceives that there is an immense difference (A).

To beings whose natural knowledge originates wholly from

(A) The discriminating powers of Aristotle will not be questioned; and in the following extract made by Cicero from some of his works which are now lost, he expresses our sentiments on this important subject with his usual precision:——"Præclare ergo Aristoteles, SI ESSENT, inquit, qui sub terra semper habitavissent, bonis, et illustribus domiciliis, quæ essent ornata signis atque picturis, instructaque rebus iis omnibus, quibus abundant ii, qui beati putantur, nec tamen exissent unquam supra terram; ACCEPISSENT AUTEM FAMA ET AUDITIONE, ESSE QUODDAM NUMEN,

Preliminary Directions.

from sensation, and whose minds cannot, but by much discipline, advance from sense to science, a long series of revelations might be necessary to give them at first just notions of God and his attributes, and to enable them to perceive the relation between the effect and its cause, so as to infer by the powers of their own reason the existence of the Creator from the presence of his creatures. Such revelations, however, could be satisfactory only to those who immediately received them. Whenever the Deity has been pleased by supernatural means to communicate any information to man, we may be sure that he has taken effectual care to satisfy the person so highly favoured that his understanding was not under the influence of any illusion; but such a person could not communicate to another the knowledge which he had thus received by any other means than an address to his rational faculties. No man can be required to believe, no man indeed can believe, without proof, that another, who has no more faculties either of sensation or intellect than himself, has obtained information from a source to which he has no possible access. An appeal to miracles would in this case serve no purpose; for we must believe in the existence, power, wisdom, and justice of God, before a miracle can be admitted as evidence of any thing but the power of him by whom it is performed. See MIRACLE.

8 to the earliest mortals by repeated revelations;

9 and yet may be properly termed natural principles.

It is therefore undeniable that there are some principles of theology which may be called *natural*; for though it is in the highest degree probable that the parents of mankind received all their theological knowledge by *supernatural* means, it is yet obvious that some parts of that knowledge must have been capable of a proof purely rational, otherwise not a single religious truth could have been conveyed through the succeeding generations of the human race but by the immediate inspiration of each individual. We indeed admit many propositions as certainly true, upon the sole authority of the Jewish and Christian scriptures, and we receive these scriptures with gratitude as the lively oracles of God; but it is self-evident that we could not do either the one or the other, were we not convinced by natural means that God exists, that he is a being of goodness, justice, and power, and that he inspired with divine wisdom the penmen of these sacred volumes. Now, though it is very possible that no man or body of men, left to themselves from infancy in a desert world, would ever have made a theological discovery; yet whatever propositions relating to the being and attributes of the first cause and the duty of man, can be demonstrated by human reason, independent of written revelation, may be called *natural theology*, and are of the utmost importance, as being to us the first principles of all religion. Natural theology, in this sense of the word, is the foundation of the Christian revelation; for without a previous knowledge of it, we could have no evidence that the scriptures of the Old and New Testaments are indeed the word of God.

10 Natural theology to be studied before the doctrines of revelation.

Our young divine, therefore, in the regular order of his studies ought to make himself master of *natural theology* before he enter upon the important task of searching the scriptures. On this subject many books have been published in our own and other languages; but perhaps there is none more worthy of attention than the Religion of Nature delineated, by Mr Wollaston (B). It is a work of great merit, and bears ample testimony to its author's learning and acuteness: yet we think it ought to be read with caution. Mr Wollaston's theory of moral obligation is fanciful and groundless; and whilst we readily acknowledge that he demonstrates many truths with elegance and perspicuity, we cannot deny that he attempts a proof of others, for which we believe no other evidence can be brought than the declarations of Christ and his apostles in the holy scriptures. To supply the defects of his theory of morals, we would recommend to the student an attentive perusal of Cumberland on the Law of Nature, and Paley's Elements of Moral Philosophy. A learned author † affirms of Cumberland, that "he excels all men in fixing the

11 Books recommended.

† *Warburton.*

NUMEN, ET VIM DEORUM; deinde aliquo tempore, patefactis terræ faucibus, ex illis abditis sedibus evadere in hæc loca, quæ nos incolimus, atque exire potuissent: cum repente terram, et maria, cœlumque vidissent: nubium magnitudinem, ventorumque vim cognovissent, adspexissentque solem, ejusque tum magnitudinem, pulchritudinemque, tum etiam efficientiam cognovissent, quod is diem efficeret, toto cœlo luce diffusa: cum autem terras nox opacasset, tum cœlum totum cernerent astris distinctum et ornatum, lunæque luminum varietatem tum crescentis, tum senescentis, eorumque omnium ortus et occasus, atque in omni æternitate ratos, immutabilesque cursus: hæc cum viderent, PROFECTO ET ESSE DEOS, et HÆC TANTA OPERA DEORUM ESSE arbitrarentur." *De Nat. Deorum*, lib. ii. § 37.

From this passage it is evident, that the Stagyrite, though he considered the motions of the heavenly bodies, the ebbing and flowing of the sea, and the other phenomena of nature, as affording a complete *proof* of the being and providence of God, did not however suppose that from these phenomena an untaught barbarian would *discover* this fundamental principle of religion. On the contrary, he expressly affirms, that before a man can feel the force of the evidence which they give of this important truth, he must have HEARD of the existence and power of God.

(B) It may not be improper to inform the reader, that Mr Wollaston, the author of the Religion of Nature, was a different man from Mr Woolston, who blasphemed the miracles of our Saviour. The former was a clergyman of great piety, and of such moderate ambition as to refuse one of the highest preferments in the church of England when it was offered to him; the latter was a clergyman likewise, but remarkable only for gloomy infidelity, and a perverse desire to deprive the wretched of every source of comfort. In the mind of the former, philosophy and devotion were happily united; in the mind of the latter, there was neither devotion nor science. Yet these writers have been frequently confounded; sometimes through inadvertence from the similarity of their names; and sometimes, we are afraid, designedly, from a weak and bigotted abhorrence of every system of religion that pretends to have its foundation in reason and in the nature of things.

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the true grounds of moral obligation, out of which natural law and natural religion both arise;" and we have ourselves never read a work in which the various duties which a man owes to his Maker, himself, and his fellow-creatures, are more accurately stated or placed on a surer basis than in the moral treatise of the archdeacon of Carlisle.

As Wollaston demonstrates with great perspicuity, the being and many of the attributes of God, it may perhaps appear superfluous to recommend any other book on that subject. The present age, however, having among other wonderful phenomena, witnessed a revival of *Atheism*, we would advise our student to read with much attention Cudworth's Intellectual System, and to read it rather in Mosheim's Latin translation than in the author's original English. It is well known that Cudworth wrote his incomparable work in confutation of Hobbes's philosophy; but instead of confining himself to the whimsies of his antagonist, which were in a little time to sink into oblivion, he took a much wider range, and traced atheism through all the mazes of antiquity, exposing the weakness of every argument by which such an absurdity had ever been maintained. In exhausting the metaphysical questions agitated among the Greeks concerning the being and perfections of God, he has not only given us a complete history of ancient learning, as far as it relates to these inquiries, but has in fact anticipated most of the sophisms of our modern atheists, who are by no means such discoverers as they are supposed to be by their illiterate admirers.

The student having made hismself master of natural theology, and carefully endeavoured to ascertain its limits, is now prepared to enter on the important task of searching the scriptures. In doing this, he ought to divest himself as much as possible of the prejudices of education in behalf of a particular system of faith, and sit down to the study of the sacred volume as of a work to which he is an entire stranger. He ought first to read it as a moral history of facts and doctrines, beginning with the books of Moses, and proceeding through the rest, not in the order in which they are commonly published, but in that in which there is reason to believe they were written (see SCRIPTURES). If he be master of the Hebrew and Greek languages, he will doubtless prefer the original text to any version; and in this perusal we would advise him to consult no commentator, because his object at present is not to study the doctrines contained in the bible, but merely to discover what are the subjects of which it treats. Many histories of the bible have been written; and were we acquainted with a good one, we should recommend it as a clue to direct the young divine's progress through the various books which compose the sacred volume. Stackhouse's history has been much applauded by some, and as much censured by others. It is not a work of which we can express any high degree of approbation; but if read with attention, it may no doubt be useful as a guide to the series of facts recorded in the scriptures. Between the Old and New Testaments there is a great chasm in the history of the Jewish nation; but it is supplied in a very able and satisfactory manner by Dr Prideaux, whose *Old and New Testament connected* is one of the most valuable historical works in our own or any other language. Shuckford's *Sacred and Profane History of the World connected* is likewise a work of merit, and may be read with advantage as throwing light on many passages of the Old Testament: but this author is not intitled to the same confidence with Prideaux, as his learning was not so great, and his partialities seem to have been greater.

12
How the scriptures are to be studied.

In thus making himself master of the history of the Old and New Testaments, the student will unavoidably acquire some general notion of the various doctrines which they contain. These it will now be his business to study more particularly, to ascertain the precise meaning of each, and to distinguish such as relate to the whole human race, from those in which Abraham and his posterity were alone interested. He must therefore travel over the sacred volume a second time; and still we would advise him to travel without a guide. From Walton's *Polyglot bible*, and the large collection called *Critici sacri*, he may indeed derive much assistance in his endeavours to ascertain the sense of a difficult text; but we think he will do well to make little use of commentators and expositors, and still less of system-builders, till he has formed some opinions of his own respecting the leading doctrines of the Jewish and Christian religions.

"Impressed (says an able writer) with an awful sense of the importance of the sacred volume, the philosophical divine will shake off the bias of prejudices however formed, of opinions however sanctioned, and of passions however constitutional, and bring to the study of it the advantage of a pure and impartial mind. Instead of wasting all his labour upon a number of minute and less significant particulars, and of refining away plain and obvious sense by the subtleties of a narrow and corrosive mind, his first object will be to institute a theological inquiry into the general design of the written word, and from principles fully contained and fairly understood, to illustrate the true *nature* and *genius of the religious dispensation* in all its parts. He will mark the difference between the first and second covenants, and observe the connection that subsists between them. He will trace the temporary economy of the *Old Testament*, and weigh the nature and intent of the *partial covenant* with the Jews; observing with astonishment how it was made introductory of better things to come: and he will follow it through the *law* and the *prophets* in its wonderful evolutions, till he see this vast and preparatory machine of providence crowned and completed in the eternal gospel. This *New Testament*, the last and best part of the religious dispensation, he will pursue through the sacred pages of that gospel with redoubled attention; contemplating the divine foundation on which it claims to be built, the supernatural *means* by which it was executed, and the immortal end which it has in view†."

In the course of this inquiry into the import of the sacred volume, the student will pay particular attention to the circumstances of the age and country in which its various writers respectively lived, and to the nature of the different *styles*, *analogical* and *parabolical*, in which it is written. He will likewise keep in mind that God, whom it claims for its author, is the parent of truth, and that all his actions and dispensations must be consistent with one another. He will therefore compare the different passages of the Old and New Testaments which relate to the same doctrine, or to the same event, reasonably concluding that the bible must be the best interpreter of itself; and though the opinions which he thus forms

† *Tatham's Chart and Scale of Truth.*

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13 Approved systems of divinity. As we have supposed that every man, after having formed a theological system of his own, will consult the systems of others, it may perhaps be expected that we should here recommend those which, in our opinion, are most worthy of his attention. To do this, however, would, we apprehend, be an interference with the rights of private judgment. But lest we should be suspected of wishing to bias the mind of the young student toward the short system which we are obliged to give, we shall just observe, that by the divines of what is called the *Arminian school*, Episcopius's *Theologiæ Institutiones*, Limborch's *Theologia Christiana*, and Locke's *Reasonableness of Christianity*, have long been held in the highest esteem; whilst the followers of Calvin have preferred the *Institutiones* of their master, Turretine's *Institutio Theologiæ Elencticæ*, and Gill's *Body of Divinity*. This last work has many merits and many defects. Its style is coarse and tedious; and the author embraces every opportunity of introducing the discriminating tenets of his sect: but his book is fraught with profound learning, breathes the spirit of piety, and may be read with advantage by every divine who has previously formed the outlines of a system for himself.

14 Books recommended on the Mosaic dispensation. As the Jewish and Christian dispensations are closely linked together, being only part of one great whole, it is impossible to have an adequate notion of the latter without understanding the design of the former. Now, though the Mosaic religion is nowhere to be learned but in the Old Testament, it may be convenient for our student, after he has formed his own opinions of it from that sacred source, to know what has been written on the subject by others. For illustrating the ritual law, a learned prelate warmly recommends the *Ductor Dubitantium* of Maimonides, and Spencer's book entitled *De Legibus Hebræorum Ritualibus*. Both works have undoubtedly great merit; but our young divine will do well to read along with them *Hermanni Witsii Ægyptiaca*, and Dr Woodward's Discourse on the Worship of the Ancient Egyptians, where some of Spencer's notions are shortly and ably refuted. On the other parts of this dispensation, such as the nature of its civil government; the rewards and punishments peculiar to it (c); its extraordinary administration by appointed agents, endowed with supernatural powers, and with the gifts of miracles and prophecy; the *double sense* in which the latter is sometimes involved; and the language consequent on its nature and use—the reader will find much erudition and ingenuity displayed in the second part of Warburton's *Divine Legation of Moses demonstrated*. That work is entitled to a serious perusal; for it displays great learning and genius, and, we believe, the heaviest censures have fallen on it from those by whom it was never read.

15 Inquiry to be made into the reality of revelation. Having proceeded thus far in the course, the student's next business should be to inquire seriously what evidence there is that the doctrines which he has so carefully studied were indeed revealed in times past by God. He must already have perceived, in the nature and tendency of the doctrines themselves, strong marks of their origin being more than human; but he must likewise have met with many difficulties, and he must prepare himself to repel the attacks of unbelievers. Here he will find opportunities of exerting the utmost powers of his reasoning faculties, and of employing in the service of religion all the stores he may have amassed of human learning. The scriptures pretend to have been written by several men who lived in different ages of the world; but the latest of them in an age very remote from the present. His first business therefore must be to prove the authenticity of these books, by tracing them up by historical evidence to the several writers whose names they bear. But it is not enough to prove them authentic. They profess to have been written by men divinely inspired, and of course infallible in what they wrote. He must therefore inquire into the truth of this inspiration. The Bible contains a number of truths doctrinal and moral, which are called *mysteries*, and asserted to be the immediate dictates of God himself. To evince this great point to man, a number of supernatural *tests* and *evidences* are inseparably connected with those mysteries; so that if the former be true, the latter must be so likewise. He must therefore examine these tests and evidences, to establish the divinity of the Holy Scriptures; and in this part of his course he will find much assistance from many writers whose defences of the truth and divinity of the Christian religion do honour to human nature.

16 Books recommended on that subject. The first step towards the embracing of any truth is, to get fairly rid of the objections which are made to it; and the general objections made by deistical writers to the Christian revelation are by no writer more completely removed than by Bishop Butler, in his celebrated work entitled *The Analogy of Religion natural and revealed to the Constitution and Course of Nature*. This book therefore the student should read with attention and meditate on with patience; but as it does not furnish a *positive proof* of the divinity of our religion, he should pass from it to *Grotius de Veritate Religionis Christianæ*, and Stillingfleet's *Origines Sacræ*. Both these works are excellent; and the latter, which may be considered

(c) On this subject the reader will find many excellent observations in Bishop Bull's *Harmonia Apostolica*, with its several defences, and in a small book of Dr Wells's, entitled A Help for the Right Understanding of the several Divine Laws and Covenants, whereby man has been obliged through the several ages of the world to guide himself in order to salvation.

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considered as an improvement of the former, is perhaps the fullest and ablest defence of revelation in general that is to be found in any language. In this part of the united kingdom it is now indeed scarcely mentioned, or mentioned with indifference; but half a century ago the English divines thought it a subject of triumph, and styled its author their *incomparable Stillingfleet*. Other works, however, may be read with great advantage, and none with greater than Paley's *Evidences of the Christian Religion*, and Leslie's *Short Method with the Deists;* which last work, in the compass of a very few pages, contains proofs of the divinity of the Jewish and Christian revelations, to which the celebrated Dr Middleton confessed (D), that for 20 years he had laboured in vain to fabricate a specious answer (E).

17. Jewish controversy to be studied,

Having satisfied himself of the truth of revelation in general, it may be worth the young divine's while to provide a defence of the Christian religion against the objections of modern Judaism. In this part of his studies he will need no other instruction than what he may reap from Limborch's work entitled *De Veritate Religionis Christianæ amica collatio cum erudito Judæo*. "In that disputation, which was held with Orobio, he will find all that the stretch of human parts on the one hand, or science on the other, can produce to varnish error or unravel sophistry. All the papers of Orobio in defence of Judaism, as opposed to Christianity, are printed at large, with Limborch's answers, section by section; and the subtilest sophisms of a very superior genius are ably and satisfactorily detected and exposed by the strong, profound, and clear reasoning, of this renowned remonstrant †." See OROBIO and LIMBORCH.

† *Warburton's Directions for the Study of Theology.*

18 and the various controversies among Christians themselves.

The various controversies subsisting between the several denominations of Christians, about points which separate them into different churches, ought next to be studied in the order of the course; for nothing is unimportant which divides the followers of that Master whose favourite precept was *love*. It has indeed been long fashionable to decry polemical divinity as an useless, if not a pernicious, study; but it is not impossible that this fashion has had its origin in ignorance, and that it tends to perpetuate those schisms which it professes to lament. We are, however, far from recommending to the young divine a perusal of the works of the several combatants on each side of a disputed question, till he has fitted himself for judging between them by a long course of preparatory study; and the only preparation which can fit him for this purpose is an impartial study of ecclesiastical history. He who has with accuracy traced the progress of our holy religion from the days of the apostles to the present time, and marked the introduction of new doctrines, and the rise of the various sects into which the Christian world is divided, is furnished with a criterion within himself by which to judge of the importance and truth of the many contested doctrines; whilst he who, without this preparation, shall read a multitude of books on any religious controversy, will be in danger of becoming a convert to his last author, if that author possess any tolerable share of art and ingenuity.

19 Importance of ecclesiastical history, and books recommended.

There are many histories of the Christian church which possess great merit, but we are acquainted with none which appears to us wholly impartial. Mosheim's is perhaps the most perfect compend (F); and one of its greatest excellencies is, that on every subject the best writers are referred to for fuller information. These indeed should often be consulted, not only to supply the defects necessarily resulting from the narrowness of the limits which the author, with great propriety, prescribed to himself; but also to correct his partial obliquities; for with all his merits, and they were many and great, he is certainly not free from the influence of prejudice. Indeed there is no coming at the true history of the primitive church, but by studying the works of the primitive writers; and the principal works of the first four centuries will amply reward the labour of perusing them (G). The rise and progress of the reformation in general, the most important period of church-history, may be best learned from Sleidan's book *De Statu Religionis et Reipublicæ, Carolo V. Cæsare, Commentarii;* the History of the Reformation of the Church of Scotland from Knox and Spotiswood; and that of the Church of England from the much applauded work of Bishop Burnet.

After this course of ecclesiastical history, the young divine may read with advantage the most important controversies which have agitated the Christian world. To enumerate these controversies, and to point out the ablest authors who have written on each, would be a tedious, and perhaps not a very profitable task. On one controversy, however, we are induced to recommend a very masterly work, which is Chillingworth's book against Knott, entitled *The Religion of Protestants a safe way to Salvation;* in which the school jargon of that Jesuit is admirably exposed, and the long dispute between

(D) This piece of information we had from the late Dr Berkeley, prebendary of Canterbury, who had it from Archbishop Seeker, to whom the confession was made.

(E) To these defences of revelation we might have added the collection of sermons preached at Boyle's lecture from 1691 to 1732, published in three volumes folio, 1739; the works of Leland; Bishop Newton's Dissertations on Prophecy; and above all, Lardner's Credibility of the Gospel History, with the Supplement to it. But there would be no end of recommending eminent writers on this subject. We have mentioned such as we most approve among those with whom we are best acquainted; but we must, once for all, caution the reader against supposing that we approve of *every* thing to be found in any work except the sacred Scriptures.

(F) The bishop of Landaff, in the catalogue of books published at the end of his Theological Tracts, recommends several other ecclesiastical histories as works of great merit; such as Dupin's, Echard's, Gregory's, and Formey's, together with *Paul Ernesti Jablonski Institutiones Historiæ Christianæ*, published at Frankfort in three volumes, 1754-67.

(G) For a proof of this position, and for a just estimate of the value of the *Fathers*, as they are called, see the introduction to Warburton's Julian, and Kett's Sermons at Bampton's Lectures.

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20 Toleration. One of the most plausible objections to the study of polemical divinity, is its tendency to give a rigid turn to the sentiments of those long engaged in it; whilst we know, from higher authority that "the end of the commandment is charity." But for preserving charity in the minds of Christians, there are better means than absolute ignorance or indifference to truth. Charity is violated only when a church unreasonably restrains the inquiries of its own members, or exercises intolerance towards those who have renounced its jurisdiction. The injustice of the first species of ecclesiastical tyranny is exposed in a very masterly manner by Jeremy Taylor in his *Liberty of Prophecying*, and by Stillingfleet in his *Irenicum;* the injustice of the second, by Locke in his celebrated Letters on Toleration. The man who shall peruse these three works, and impartially weigh the force of their arguments, will be in little danger of thinking uncharitably of those from whose principles the love of truth may compel him to dissent.

In these directions for the study of theology, we might have enumerated many more books on each branch of the subject well deserving of the most attentive perusal; but he who shall have gone through the course here recommended, will have laid a foundation on which he may raise such a superstructure as will entitle him to the character of an accomplished divine. His diligence must indeed be continued through life; for when a man ceases to make acquisitions in any department of learning, he soon begins to lose those which he has already made; and a more contemptible character is nowhere to be found than that of a clergyman unacquainted with the learning of his profession. This learning, however, is not to be acquired, and indeed is scarcely to be preserved, by studying *bodies* or *institutes* of *theology;* and though we have mentioned a few generally approved by two rival sects of Christians, and must in conformity with the plan of our work, give another ourselves, we do not hesitate to declare, that the man who has carefully gone through the course of study which we have recommended, though it be little more than the outlines on which he is to work, may, with no great loss to himself, neglect ours and all other systems. For as an excellent writer *, whom we have often quoted, well observes, "to judge of the *fact* whether such a revelation containing such a principle, with its mysteries and credentials, was actually sent from God, and received by man, by examining the *evidences* and *circumstances* which accompanied it—the *time* when, the *place* where, the *manner* how, it was delivered—the *form* in which it descends to us—and in what it is *contained*—together with the particular *substance* and *burden* of it—and how every part is to be rightly *understood:* these are the various and extensive subjects which constitute the sublime office of THEOLOGIC REASONING and the PROPER STUDY OF DIVINITY." On this account we shall pass over slightly, many things which every clergyman ought thoroughly to understand, and confine ourselves, in the short compend which we are to give, to the chief articles of Christian theology. In doing this, we shall endeavour to divest ourselves of party prejudices; but as we are far from thinking that this endeavour will be completely successful (for we believe there is no man totally free from prejudice), we cannot conclude this part of the article more properly than with the following solemn CHARGE, with which a very learned divine ‡ always prefaced his Theological Lectures.

* *Tatham.*

‡ *Dr Taylor of Norwich.*

21 A charge to students of theology.

I. "I do solemnly charge you, in the name of the God of Truth, and of our Lord Jesus Christ, who is the Way, the Truth, and the Life, and before whose judgement-seat you must in no long time appear, that in all your studies and inquiries of a religious nature, present or future, you do constantly, carefully, impartially, and conscientiously, attend to evidence, as it lies in the Holy Scriptures, or in the nature of things, and the dictates of reason; cautiously guarding against the sallies of imagination, and the fallacy of ill-grounded conjecture.

II. "That you admit, embrace, or assent to no principle or sentiment by me taught or advanced, but only so far as it shall appear to you to be supported and justified by proper evidence from revelation or the reason of things.

III. "That if, at any time hereafter, any principle or sentiment by me taught or advanced, or by you admitted or embraced, shall, upon impartial and faithful examination, appear to you to be dubious or false, you either suspect or totally reject such principle or sentiment.

IV. "That you keep your mind always open to evidence: That you labour to banish from your breast all prejudice, prepossession, and party-zeal: That you study to live in peace and love with all your fellow Christians; and that you steadily assert for yourself, and freely allow to others, the unalienable rights of judgment and conscience."

PART I. OF NATURAL THEOLOGY.

SECT. I. *Of the Being and Attributes of God.*

HE who cometh to God, says an ancient divine †, deeply read in the philosophy of his age, must believe that he is, and that he is a rewarder of them who diligently seek him. This is a truth as undeniable as that a man cannot concern himself about a nonentity. The existence of God is indeed the foundation of all religion, and the first principle of the science which is the subject of this article. It is likewise a principle which must command the assent of every man who has any notion of the relation between effects and their causes, and whose curiosity has ever been excited by the phenomena of nature. This great and important truth we have elsewhere endeavoured to demonstrate (see METAPHYSICS, Part III. Chap. vi.); but it may be proved by arguments less abstracted than the nature of that article required us to use. Of these we shall give one or two, which we hope will be level to every ordinary capacity; while, at the same time, we earnestly recommend to the young divine a diligent study of those books on the

† *St Paul.*

22 The being of God proved from

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the subject which we have mentioned in the preceding directions.

23 propagation of animals.

We see that the human race, and every other species of animals, is at present propagated by the co-operation of two parents; but has this process continued from eternity? A moment's reflection will convince us that it has not. Let us take any one man alive, and let us suppose his father and mother dead, and himself the only person at present existing: how came he into the world? It will be said he was produced mechanically or chemically by the conjunction of his parents, and that his parents were produced in the same manner by theirs. Let this then be supposed; it must surely be granted, that when this man was born, an addition was made to the series of the human race. But a series which can be enlarged may likewise be diminished; and by tracing it backwards, we must at some period, however remote, reach its beginning. There must therefore have been a first pair of the human race, who were not propagated by the conjunction of parents. How did these come into the world?

Anaximander tells us *, that the first men and all animals were bred in warm moisture, inclosed in crustaceous skins like crab-fish or lobsters; and that when they arrived at a proper age, their shelly prisons growing dry, broke, and made way for their liberty. Empedocles informs us, that mother Earth at first brought forth vast numbers of legs, and arms, and heads, &c. which approaching each other, arranging themselves properly, and being cemented together, started up at once full grown men.

* See *Bentley's Boyle's Lectures.*

Surely those sages, or their followers, should have been able to tell us why the earth has not in any climate this power of putting forth vegetable men or the parts of men at present. If this universal parent be eternal and self-existent, it must be incapable of decay or the smallest change in any of its qualities; if it be not eternal, we shall be obliged to find a cause for its existence, or at least for its form and all its powers. But such a cause may have produced the first human pair, and undoubtedly did produce them, without making them spring as plants from the soil. Indeed the growth of plants themselves clearly evinces a cause superior to any vegetative power which can be supposed inherent in the earth. No plant can be propagated but from seed or slips from the parent stock; but when one contemplates the regular process of vegetation, the existence of every plant implies the prior existence of a parent seed, and the existence of every seed the prior existence of a parent plant. Which then of these, the oak or the acorn, was the first, and whence was its existence derived? Not from the earth; for we have the evidence of universal experience that the earth never produces a tree but from seed, nor seed but from a tree. There must therefore be some superior power which formed the first seed or the first tree, planted it in the earth, and gave to it those powers of vegetation by which the species has been propagated to this day.

24 and vegetables.

25 and from the laws of attraction and repulsion, &c.

Thus clearly do the processes of generation and vegetation indicate a power superior to those which are usually called the *powers of nature*. The same thing appears no less evident from the laws of attraction and repulsion, which plainly prevail through the whole system of matter, and hold together the stupendous structure. Experiment shows that very few particles of the most solid body are in actual contact with each other (see OPTICS, N° 63—68. PHYSICS, N° 23.); and that there are considerable interstices between the particles of every elastic fluid, is obvious to the smallest reflection. Yet the particles of solid bodies strongly cohere, whilst those of elastic fluids repel each other. How are these phenomena accounted for? To say that the former is the effect of attraction and the latter of repulsion, is only to say that two individual phenomena are subject to those laws which prevail through the whole of the classes under which they are respectively arranged; whilst the question at issue is concerning the ORIGIN OF THE LAWS THEMSELVES, the *power* which makes the particles of gold cohere, and those of air repel each other. Power without substance is inconceivable; and by a law of human thought, no man can believe a being to operate but where it is in some manner or other actually present: but the particles of gold adhere, and the particles of air keep at a distance from each other, by powers exerted where no matter is present. There must therefore be some substance endowed with power which is not material.

Of this substance or being the power is evidently immense. The earth and other planets are carried round the sun with a velocity which human imagination can scarcely conceive. That this motion is not produced by the agency of these vast bodies on one another, or by the interposition of any material fluid, has been shown elsewhere (see METAPHYSICS, N° 196—200. and OPTICS, N° 67.); and since it is a law of our best philosophy, *that we are not to multiply substances without necessity*, we must infer that the same Being which formed the first animals and vegetables, endowing them with powers to propagate their respective kinds, is likewise the cause of all the phenomena of nature, such as *cohesion*, *repulsion*, *elasticity* and *motion*, even the motions of the heavenly bodies themselves.

If this powerful Being be self-existent, intelligent, and independent in his actions and volitions, he is an original or first cause, and that Being whom we denominate GOD. If he be not self-existent and independent, there must be a cause in the order of nature prior and superior to Him, which is either itself the first cause, or a link in that series of causes and effects, which, however vast we suppose it, must be traced ultimately to some one Being, who is self-existent, and has in himself the power of beginning motion, independent of every thing but his own intelligence and volition. In vain have atheists alleged, that the series may ascend infinitely, and for that reason have no first mover or cause. An infinite series of successive beings involves an absurdity and contradiction (see METAPHYSICS, N° 288.): but not to insist on this at present, we shall only beg leave to consider such a series as a whole, and see what consequence will flow from the supposition. That we may with logical propriety consider it in this light, is incontrovertible; for the birth of each individual of the human race shows that it is made up of parts; but parts imply a whole as necessarily as an attribute implies its subject. As in this supposed series there is no cause which is not likewise an effect, nor any body moving another which was not itself moved by a third, the whole is undeniably equivalent to an infinite effect, or an infinite body moved: but if a finite effect must necessarily have proceeded from a cause, and a finite body in

26 Absurdity of an infinite series of effects.

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in motion must have been put into that state by a mover, is there a human mind which can conceive an infinite effect to have proceeded from *no* cause, or an infinite body in motion to have been moved by *nothing*? No, surely! An infinite effect, were such a thing possible, would compel us to admit an infinite cause, and an infinite body in motion a mover of infinite power.

This great cause is GOD, whose wisdom, power, and goodness, all nature loudly proclaims. That the phenomena which we daily see evince the existence of *one* such Being, has just been shown; and that we have no reason to infer the existence of *more* than *one*, is very evident. For, not to lay more stress than it will bear on that rule of Newton's, which forbids us to multiply substances without necessity, such a harmony prevails through the whole visible universe, as plainly shows it to be under the government of one intelligence. That on this globe the several elements serve for nourishment to plants, plants to the inferior animals, and animals to man; that the other planets of our system are probably inhabited, and their inhabitants nourished in the same or a similar manner; that the sun is so placed as to give light and heat to all, and by the law of gravitation to bind the whole planets into one system with itself—are truths so obvious and so universally acknowledged, as to supersede the necessity of establishing them by proof. The fair inference therefore is, that the solar system and all its parts are under the government of *one intelligence*, which directs all its motions and all the changes which take place among its parts for some wise purposes. To suppose it under the government of two or more intelligences would be highly unreasonable; for if these intelligences had equal power, equal wisdom, and the same designs, one of them would evidently be superfluous; and if they had equal power and contrary designs, they could not be the parents of that harmony which we clearly perceive to prevail in the system.

27 There is only one original cause.

But the Being capable of regulating the movements of so vast a machine, may well be supposed to possess infinite power, and to be capable of superintending the motions of the universe. That the widely extended system of nature is but one system, of which the several parts are united by many bonds of mutual connection, has been shown elsewhere (see PHYSICS), and appears daily more and more evident from our progress in physical discoveries; and therefore it is in the highest degree unreasonable to suppose that it has more than one author, or one supreme governor.

28 Of infinite power, wisdom, and

As the unity of design apparent in the works of creation plainly proves the unity of their Author, so do the immensity of the whole, and the admirable adjustment of the several parts to one another, demonstrate His power and His wisdom. On this subject the following beautiful reflections by Mr Wollaston are deserving of the most serious attention.

"In order (says that able writer *) to prove to any one the grandness of this fabric of the world, one needs only to bid him consider the *sun*, with that insupportable glory and lustre that surrounds it; to demonstrate its vast distance, magnitude, and heat; to represent to him the chorus of planets moving periodically, by uniform laws, in their several orbits about it; guarded some of them by secondary planets, and as it were emulating the state of the sun, and probably all possessed by proper inhabitants; to remind him of those surprising visits which the *comets* make to us, and the large trains of uncommon splendour which attend them, the far country from which they come, and the curiosity and horror which they excite not only among us, but in the inhabitants of other planets, who may also be up to see the entry and progress of these ministers of fate; to direct his eye and contemplation through those azure fields and vast regions above him up to the *fixed stars*, that radiant numberless host of heaven; and to make him understand how unlikely a thing it is that they should be placed there only to adorn and bespangle a canopy over our heads; to convince him that they are rather so many *other suns*, with their several systems of planets about them; to show him by the help of glasses still more and more of these fixed lights, and to beget in him an apprehension of their inconceivable numbers, and those immense spaces that lie beyond our reach and even our imagination: One needs but to do this (continues our author), and explain to him such things as are now known almost to every body; and by it to show, that if the world be not infinite, it is *infinito similis*, and undoubtedly the work of an INFINITE ARCHITECT.

* *Religion of Nature*, sect. v. prop. 14.

"But if we would take a view of all the *particulars* contained within that astonishing compass which we have thus hastily run over, how would wonders multiply upon us? Every corner, every part of the world, is as it were made up of *other* worlds. If we look upon this our earth, what scope does it furnish for admiration? The great variety of mountains, hills, valleys, plains, rivers, seas, trees, and plants! The many tribes of different animals with which it is stocked; the multifarious inventions and works of one of these, i. e. of us men; with the wonderful instincts of others, guiding them uniformly to what is best for themselves, in situations where neither sense nor reason could direct them. And yet when all these (heaven and earth) are surveyed as nicely as they can be by the help of our unassisted senses and of telescopes, we may discover by the assistance of good microscopes, in very small parts of matter, as many *new* wonders as those already discovered, new kingdoms of animals, with new and curious architecture. So that as our senses and even conception fainted before in the vast journeys we took in considering the expanse of the universe, they here again fail us in our researches into the principles and minute parts of which it is composed. Both the *beginnings* and the *ends* of things, the *least* and the *greatest*, all conspire to baffle us; and which way soever we prosecute our inquiries, we still meet with fresh subjects of amazement, and fresh reasons to believe that there are indefinitely more and more behind, that will forever escape our eagerest pursuits and deepest penetration.

"In this vast assemblage, and amidst all the multifarious motions by which the several processes of generation and corruption, and the other phenomena of nature, are carried on, we cannot but observe that there are stated methods, as so many forms of proceeding, to which things punctually and religiously adhere. The same *causes* circumstanced in the same manner produce always the same *effects*; all the *species* of animals among us are made according to one general *idea*; and so are those of *plants* also, and even of *minerals*. No new species are brought forth or have arisen anywhere; and the old are preserved and continued by the *old ways*.

"It appears, lastly, beyond dispute, that in the part

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and model of the world there is a contrivance for accomplishing certain ends. The sun is placed near the centre of our system, for the more convenient dispensing of his benign influences to the planets moving about him; the place of the earth's *equator* intersects that of her *orbit*, and makes a proper angle with it, in order to diversify the *year*, and create an useful variety of *seasons;* and many other things of this kind will be always observed, and though a thousand times repeated, be meditated upon with pleasure by good men and true philosophers. Who can observe the vapours to ascend, especially from the sea, meet above in clouds, and fall again after condensation, without being convinced that this is a kind of *distillation*, in order to clear the water of its grosser salts, and then by rains and dews to supply the fountains and rivers with fresh and wholesome liquor; to nourish the vegetables below by showers, which descend in drops as from a *watering-pot* upon a garden? Who can view the *structure* of a plant or animal, the indefinite number of its fibres and fine vessels, the formation of larger vessels, and the several members out of them, with the apt disposition of all these; the means contrived for the reception and distribution of *nutriment;* the *effect* this nutriment has in extending the vessels, bringing the vegetable or animal to its full growth and expansion, continuing the *motion* of the several fluids, repairing the decays of the body, and preserving *life?* Who can take notice of the several *faculties* of animals, their arts of saving and providing for themselves, or the ways in which they are provided for; the uses of plants to animals, and of some animals to others, particularly to mankind; the care taken that the several species should be propagated, without confusion, from their proper seeds; the strong inclination planted in animals for that purpose, the love of their young and the like.—Who (says our author) can observe all this, and not see a *design* in such *regular* pieces, so nicely wrought and so admirably preserved? If there were but one animal in existence, and it could not be doubted but that his eyes were formed that he might see with them, his ears that he might hear with them, and his feet to be instruments by which he might remove himself from place to place; if *design* and *contrivance* can be much less doubted, when the same things are repeated in the individuals of all the tribes of animals; if the like observations be made with respect to vegetables and other things; and if all these *classes* of things, and much more the *individuals* comprehended under them, be inconceivably numerous, as most unquestionably they are—one cannot but be convinced, from what so plainly runs through the nobler parts of the visible world, that not only *they*, but other things, even those that seem to be *less noble*, have their ends likewise, though not always perceived by capacities limited like ours. And since we cannot, with the Epicureans of old, suppose the parts of matter to have *contrived* among themselves this wonderful form of a world, to have taken by agreement each its respective *post*, and then to have pursued in conjunction constant *ends* by certain methods and measures *concerted*, there must be some other Being, whose wisdom and power are equal to such a mighty work as is the *structure* and *preservation* of the world. There must be some Almighty Mind who modelled and preserves it; lays the causes of things so deep; prescribes them such uniform and steady laws; destines and adapts them to certain purposes; and makes one thing to fit and answer another so as to produce one harmonious whole. Yes,

> These are thy glorious works, Parent of good!
> Almighty, thine this universal frame,
> Thus wondrous fair; Thyself how wondrous then!

How wondrous in wisdom and in power!"

29 Goodness.

But the GOODNESS of God is not less conspicuous in his works than His power or His wisdom. Contrivance proves design, and the predominant tendency of the contrivances indicates the disposition of the designer. "The world (says an elegant and judicious writer *) abounds with contrivances, and all the contrivances in it with which we are acquainted are directed to beneficial purposes. Evil no doubt exists; but it is never that we can perceive the object of contrivance. Teeth are contrived to eat, not to ache; their aching now and then is incidental to the contrivance, perhaps inseparable from it; but it is not its object. This is a distinction which well deserves to be attended to. In describing implements of husbandry, one would hardly say of a sickle that it is made to cut the reaper's fingers, though from the construction of the instrument, and the manner of using it, this mischief often happens. But if he had occasion to describe instruments of torture or execution, this, he would say, is to extend the sinews; this to dislocate the joints; this to break the bones; this to scorch the soles of the feet. Here pain and misery are the very objects of the contrivance. Now nothing of this sort is to be found in the works of nature. We never discover a train of contrivance to bring about an evil purpose. No anatomist ever discovered a system of organization calculated to produce pain and disease; or, in explaining the parts of the human body, ever said, this is to irritate, this to inflame, this duct is to convey the gravel to the kidneys, this gland to secrete the humour which forms the gout. If by chance he came to a part of which he knows not the use, the most that he can say is, that to him it appears to be useless: no one ever suspects that it is put there to incommode, to annoy, or to torment. If God had wished our misery, he might have made sure of his purpose, by forming our senses to be as many sores and pains to us as they are now instruments of gratification and enjoyment; or, by placing us among objects so ill suited to our perceptions as to have continually offended us, instead of ministering to our refreshment and delight. He might have made, for instance, every thing we tasted bitter, every thing we saw loathsome, every thing we touched a sting, every smell a stench, and every sound a discord."

* Dr Paley.

Instead of this, all our sensations, except such as are excited by what is dangerous to our health, are pleasures to us: The view of a landscape is pleasant; the taste of nourishing food is pleasant; sounds not too loud are agreeable, while musical sounds are exquisite; and scarcely any smells, except such are excited by effluvia obviously pernicious to the brain, are disagreeable; while some of them, if not too long indulged, are delightful. Our lives are preserved and the species is continued by obeying the impulse of appetites; of which the gratification is exquisite when not repeated too frequently, to answer the purposes of the Author of our being. Since, then, God has called forth his consummate-

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nate wisdom to contrive and provide for our happiness, and has made those things which are necessary to our existence and the continuance of the race sources of our greatest sensual pleasures, who can doubt but that benevolence is one of his attributes; and that, if it were not impious to draw a comparison between them, it is the attribute in which he himself most delighteth?

But it is not from sensation only that we may infer the benevolence of the deity: He has formed us with minds capable of intellectual improvement, and he has implanted in the breast of every man a very strong desire of adding to his knowledge. This addition, it is true, cannot be made without labour; and at first the requisite labour is to most people irksome: but a very short progress in any study converts what was irksome into a pleasure of the most exalted kind; and he who by study, however intense, enlarges his ideas, experiences a complacency, which, though not so poignant perhaps as the pleasures of the sensualist, is such as endears him to himself, and is what he would not exchange for any thing else which this world has to bestow, except the still sweeter complacency arising from the consciousness of having discharged his duty.

That the practice of virtue is attended with a peculiar pleasure of the purest kind, is a fact which no man has ever questioned, though the immediate source of that pleasure has been the subject of many disputes. He who attributes it to a moral sense, which instinctively points out to every man his duty, and on the performance of it rewards him with a sentiment of self-approbation, must of necessity acknowledge benevolence to be one of the attributes of that Being who has so constituted the human mind. That to protect the innocent, relieve the distressed, and do to others as we would in like circumstances wish to be done by, fills the breast, previous to all reflection, with a holy joy, as the commission of any crime tears it with remorse, cannot indeed be controverted. Many, however, contend, that this joy and this remorse spring not from any moral instinct implanted in the mind, but are the consequence of early and deep-rooted associations of the practice of virtue with the hope of future happiness, and of vice with the dread of future misery. On the respective merits of these two theories we shall not now decide, but only observe, that they both lead with equal certainty to the benevolence of the Deity, who made us capable of forming associations, and subjected those associations to fixed laws. This being the case, the moral sense, with all its instantaneous effects, affords not a more convincing proof of his goodness, than that principle in our nature by which remote circumstances become so linked together, that the one circumstance never occurs without bringing the other also into view. It is thus that the pleasing complacency, which was perhaps first excited by the hopes of future happiness, comes in time to be so associated with the consciousness of virtuous conduct, the only thing entitled to reward, that a man never performs a meritorious action without experiencing the most exquisite joy diffused through his mind, though his attention at that instant may not be directed either to heaven or futurity. Were we obliged, before we could experience this joy, to estimate by reason the merit of every individual action, and trace its connection to heaven and future happiness through a long train of intermediate reasoning, we should be in a great measure deprived of the present reward of virtue; and therefore this associating principle contributes much to our happiness. But the benevolence of a Being, who seems thus anxious to furnish us with both sensual and intellectual enjoyments, and who has made our duty our greatest pleasure, cannot be questioned; and therefore we must infer, that the Author of Nature wishes the happiness of the whole sensible and intelligent creation.

30 Objections.

To such reasoning as this in support of the Divine Benevolence many objections have been made. Some of them appear at first sight plausible, and are apt to stagger the faith of him who has bestowed no time on the study of that branch of general science which is called *physics* (see PHYSICS). To omit these altogether in such an article as this might be construed into neglect; while it is certain that there is in them nothing worthy the attention of that man who is qualified either to estimate their force, or to understand the arguments by which they have often been repelled.

It has been asked, Why, if the Author of Nature be a benevolent Being, are we necessarily subject to pain, diseases, and death? The scientific physiologist replies, Because from these evils Omnipotence itself could not in our present state exempt us, but by a constant series 31
of miracles. He who admits miracles, knows likewise answered.
that mankind were originally in a state in which they were not subject to death; and that they fell under its dominion through the fault of their common progenitors. But the fall and restoration of man is the great subject of revealed religion; and at present we are discussing the question like philosophers who have no other data on which to proceed than the phenomena of nature. Now we know, that as all matter is divisible, every system composed of it must necessarily be liable to decay and dissolution; and our material system would decay and be dissolved long before it could serve the purposes of nature, were there not methods contrived with admirable wisdom for repairing the waste occasioned by perpetual friction. The body is furnished with different fluids, which continually circulate through it in proper channels, and leave in their way what is necessary to repair the solids. These again are supplied by food *ab extra*; and to the whole processes of digestion, circulation, and nutrition, the air we breath is absolutely necessary. But as the air is a very heterogenous fluid, and subject to violent and sudden changes, it is obvious that these changes must affect the blood, and by consequence the whole frame of the human body. The air indeed in process of time consumes even marble itself; and therefore we cannot wonder that as it is in one state the parent of health, it should in another be the source of disease to such creatures as man and other terrestrial animals. Nor could these consequences be avoided without introducing others much more deplorable. The world is governed by general laws, without which there could be among men neither arts nor sciences; and though laws different from those by which the system is at present governed might perhaps have been established, there is not the smallest reason to imagine that they could on the whole have been better, or attended with fewer inconveniences. As long as we have material and solid bodies capable of motion, liable to resistance from other solid bodies, supported by food,

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subject to the agency of the air, and divisible, they must necessarily be liable to pain, disease, corruption, and death, and that too by the very influence of those laws which preserve the order and harmony of the universe. Thus gravitation is a general law so good and so necessary, that were it for a moment suspended, the world would instantly fall to pieces; and yet by means of this law the man must inevitably be crushed to death on whom a tower shall chance to tumble. Again, the attraction of cohesion is a general law, without which it does not appear that any corporeal system could possibly exist: it is by this law too, or a modification of it, that the glands and lacteals of the human body extract from the blood such particles as are necessary to nourish the solids; and yet it is by means of the very same modification of the very same law that a man is liable to be poisoned.

32 Sickness, pain, and the dread of death serve good purposes.

Although the human body could not have been preserved from dangers and dissolution but by introducing evils greater on the whole than those to which it is now liable, why, it has sometimes been asked, is every disorder to which it is subject attended with sickness or with pain? and why is such a horror of death implanted in our breasts, seeing that by the laws of nature death is inevitable? We answer, That sickness, pain, and the dread of death, serve the very best purposes. Could a man be put to death, or have his limbs broken without feeling pain, the human race had long ago been extinct. Felt we no uneasiness in a fever, we should be insensible of the disease, and die before we suspected our health to be impaired. The horror which generally accompanies our reflections on death tends to make us more careful of life, and prevents us from quitting this world rashly when our affairs prosper not according to our wishes. It is likewise an indication that our existence does not terminate in this world; for our dread is seldom excited by the prospect of the pain which we may suffer when dying, but by our anxiety concerning what we may be doomed to suffer or enjoy in the next stage of our existence; and this anxiety tends more perhaps than any thing else to make us live while we are here in such a manner as to ensure our happiness hereafter.

Thus from every view that we can take of the works and laws of God, and even from considering the objections which have sometimes been made to them, we are compelled to acknowledge the benevolence of their Author. We must not, however, suppose the Divine benevolence to be a fond affection like that which is called benevolence among men. All human affections and passions originate in our dependence and wants; and it has been doubted whether any of them be at first disinterested (see PASSION): but he to whom existence is essential cannot be dependent; he who is the Author of every thing can feel no want. The Divine benevolence therefore must be wholly disinterested, and of course free from those partialities originating in self-love, which are alloys in the most sublime of human virtues. The most benevolent man on earth, though he wishes the happiness of every fellow-creature, has still, from the ties of blood, the endearments of friendship, or, perhaps

33 The divine benevolence coincident with justice.

from a regard to his own interest, some particular favourites whom, on a competition with others, he would certainly prefer. But the equal Lord of all can have no particular favourites. His benevolence is therefore coincident with justice; or, that which is called *divine justice*, is only benevolence exerting itself in a particular manner for the propagation of general felicity. When God prescribes laws for regulating the conduct of his intelligent creatures, it is not because he can reap any benefit from their obedience to those laws, but because such obedience is necessary to their own happiness; and when he punishes the transgressor, it is not because in his nature there is any disposition to which the prospect of such punishment can afford gratification, but because in the government of free agents punishment is necessary to reform the criminal, and to intimidate others from committing the like crimes.

The essence of this self-existent, all-powerful, infinitely wise, and perfectly good Being, is to us wholly incomprehensible. 34 God incomprehensible; That it is not matter, is shown by the process of argumentation by which we have proved it to exist: but what it is we know not, and it would be impious presumption to inquire. It is sufficient for all the purposes of religion to know that God is somehow or other present to every part of his work; that existence and every possible perfection is essential to him; and that he wishes the happiness of all his creatures. From these truths we might proceed to illustrate the perpetual superintendance of his providence, both general and particular, over every the minutest part of the universe: but that subject has been discussed in a separate article; to which, therefore, we refer the reader. (See PROVIDENCE). We shall only observe at present, that the manner in which animals are propagated affords as complete a proof of the constant superintendance of divine power and wisdom, as it does of the immediate exertion of these faculties in the formation of the parent pair of each species. For were propagation carried on by *necessary* and mechanical laws, it is obvious, that in every age there would be generated, in each species of animals, the very same proportion of males to females that there was in the age preceding. 35 but constantly present to his works. On the other hand, did generation depend on *fortuitous* mechanism, it is not conceivable but that, since the beginning of the world, several species of animals should in *some age* have generated nothing but *males*, and others nothing but *females*; and that of course many species would have been long since extinct. As neither of these cases has ever happened, the preservation of the various species of animals, by keeping up constantly in the world a due, though not always the same, proportion between the sexes of male and female, is a complete proof of the superintendance of Divine providence, and of that saying of the apostle, that it is "in God we live, move, and have our being."

SECT. II. *Of the Duties and Sanctions of Natural Religion.*

36 Reverence and gratitude due to God.

FROM the short view that we have taken of the divine perfections, it is evidently our duty to reverence in our minds the self-existent Being to whom they belong. This is indeed not only a duty, but a duty of which no man who contemplates these perfections, and believes them to be real, can possibly avoid the performance. He who thinks irreverently of the Author of nature, can never have considered seriously the power, the wisdom, and the goodness, displayed in his works; for whoever has a tolerable notion of these must be convinced, that he who performed them has no imperfection;

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tion; that his power can accomplish every thing which involves not a contradiction; that his knowledge is intuitive, and free from the possibility of error; and that his goodness extends to all without partiality and without any alloy of selfish design. This conviction must make every man on whose mind it is impressed ready to prostrate himself in the dust before the Author of his being; who, though infinitely exalted above him, is the source of all his enjoyments, constantly watches over him with paternal care, and protects him from numberless dangers. The sense of so many benefits must excite in his mind a sentiment of the liveliest gratitude to him from whom they are received, and an ardent wish for their continuance.

37 Of whom no positive idea should be formed.

While silent gratitude and devotion thus glow in the breast of the contemplative man, he will be careful not to form even a mental image of that all-perfect Being to whom they are directed. He knows that God is not material; that he exists in a manner altogether incomprehensible; that to frame an image of him would be to assign limits to what is infinite; and that to attempt to form a positive conception of him would be impiously to compare himself with his Maker.

38 How he ought to be spoken of; and

The man who has any tolerable notion of the perfections of the Supreme Being will never speak lightly of him, or make use of his name at all but on great and solemn occasions. He knows that the terms of all languages are inadequate and improper, when applied directly to him who has no equal, and to whom nothing can be compared; and therefore he will employ these terms with caution. When he speaks of his mercy and compassion, he will not consider them as feelings wringing the heart like the mercy and compassion experienced by man, but as rays of pure and disinterested benevolence. When he thinks of the stupendous system of nature, and hears it, perhaps, said that God formed it for his own glory, he will reflect that God is so infinitely exalted above all his creatures, and so perfect in himself, that he can neither take pleasure in their applause, nor receive any accession of any kind from the existence of ten thousand worlds. The immense fabric of nature therefore only displays the glory or perfections of its Author to *us* and to other *creatures* who have not faculties to comprehend him in himself.

39 what is meant by serving him.

When the contemplative man talks of *serving* God, he does not dream that his services can increase the divine felicity; but means only that it is his duty to obey the divine laws. Even the pronoun *He*, when it refers to God, cannot be of the same import as when it refers to man; and by the philosophical divine it will seldom be used but with a mental allusion to this obvious distinction.

As the man who daily venerates the Author of his being will not speak of him on trivial occasions, so will he be still further from calling upon him to witness impertinences and falsehood (see OATH). He will never mention his name but with a *pause*, that he may have time to reflect in silence on his numberless perfections, and on the immense distance between himself and the Being of whom he is speaking. The slightest reflection will convince him that the world with all that it contains depends every moment on that God who formed it; and this conviction will compel him to wish for the divine protection of himself and his friends from all dangers and misfortunes. Such a wish is in effect a prayer, and will always be accompanied with adoration, confession, and thanksgiving (see PRAYER). But adoration, confessions, supplication, and thanksgiving, constitute what is called *worship*, and therefore the worship of God is a natural duty. It is the addressing of ourselves as his dependants to him as the supreme cause and governor of the world, with acknowledgements of what we enjoy, and petitions for what we really want, or he knows to be convenient for us. As if, ex. gr. I should in some humble and composed manner (says Mr Wollaston) pray to that "Almighty Being, upon whom depends the existence of the world, and by whose providence I have been preserved to this moment, and enjoyed many undeserved advantages, that he would graciously accept my grateful sense and acknowledgements of all his beneficence towards me; that he would deliver me from the evil consequences of all my transgressions and follies; that he would endue me with such dispositions and powers as may carry me innocently and safely through all future trials, and may enable me on all occasions to behave myself conformably to the laws of reason piously and wisely; that He would suffer no being to injure me, no misfortunes to befal me, nor me to hurt myself by any error or misconduct of my own: that he would vouchsafe me clear and distinct perceptions of things; with so much health and prosperity as may be good for me; that I may at least pass my time in peace, with contentment and tranquillity of mind; and that having faithfully discharged my duty to my family and friends, and endeavoured to improve myself in virtuous habits and useful knowledge, I may at last make a decent and happy exit, and find myself in some better state." 40

40 Divine worship a natural duty.

That an untaught savage would be prompted by *instinct* to address the Supreme Being in such terms as this, we are so far from thinking that to us it appears not probable that such a savage, in a state of solitude, would be led by instinct to suppose the existence of that Being. But as soon as the being and attributes of God were, by whatever means, made known to man, every sentiment expressed in this prayer must necessarily have been generated in his mind; for not to be sensible that we derive our existence and all our enjoyments from God, is in effect to deny his being or his providence; and not to feel a wish that he would give us what we want, is to deny either his goodness or his power.

41 Whether or not is public worship a duty of natural religion?

The worship of God therefore is a natural duty resulting from the contemplation of his attributes and a sense of our own dependence. But the reasoning which has led us to this conclusion respects only *private* devotion; for it is a question of much greater difficulty, and far enough from being yet determined, whether *public* worship be a duty of that religion which can with any propriety be termed *natural*. Mr Wollaston indeed positively affirms that it is, and endeavours to prove his position by the following arguments.

42 Arguments for it,

"A man (says he) may be considered as a member of some society; and as *such* he ought to worship God if he has the opportunity of doing it, if there be proper prayers used publicly to which he may resort, and if his health, &c. permit. Or the society may be considered as *one body*, that has common interests and concerns, and *as such* is obliged to worship the Deity, and offer one prayer. Besides, there are many who know not, of themselves

themselves how to pray; perhaps cannot so much as read. These must be taken *as they are;* and consequently some time and place *appointed* where they may have suitable prayers read to them, and be guided in their devotions. And further, towards the keeping mankind in order, it is *necessary* there should be some religion professed, and even established, which cannot be without public worship. And were it not for that sense of virtue which is *principally* preserved (so far as it is preserved) by national *forms* and *habits* of religion, men would soon lose it *all*, run wild, prey upon one another, and do what else the worst of savages do."

These are in themselves just observations, and would come with great force and propriety from the tongue or pen of a Christian preacher, who is taught by revelation that the Master whom he serves has commanded his followers "not to forsake the assembling of themselves together," and has promised, "that if two of them shall agree on earth as touching any thing that they shall ask, it shall be done for them of his Father who is in heaven." As urged by such a man, and on such grounds, they would serve to show the fitness of the divine command, and to point out the benefits which a religious obedience to it might give us reason to expect. But the author is here professing to treat of *natural* religion, and to state the duties which result from the mere relation which subsists between man as a creature and God as his creator and constant preserver. Now, though we readily admit the benefits of public worship as experienced under the Christian dispensation, we do not perceive any thing in this reasoning which could lead a pious theist to expect the same benefit previous to all experience. When the author thought of *national forms*

43 borrowed from revelation.

and *establishments of religion*, he certainly lost sight of his proper subject, and, as such writers are too apt to do, comprehended under the religion of nature what belongs only to that which is revealed. Natural religion, in the proper sense of the words, admits of no particular *forms*, and of no *legal establishment*. Private devotion is obviously one of its duties, because sentiments of adoration, confession, supplication, and thanksgiving, necessarily spring up in the breast of every man who has just notions of God and of himself: but it is not so obvious that such notions would induce any body of men to meet at *stated times* for the purpose of expressing their devotional sentiments in public. Mankind are indeed social beings, and naturally communicate their sentiments to each other; but we cannot conceive what should at first have led them to think that public worship at stated times would be acceptable to the self-existent Author of the universe. In case of a famine, or any other calamity in which the whole tribe was equally involved, they might speak of it to each other, inquire into its cause, and in the extremity of their distress join perhaps in one fervent petition, that God would remove it. In the same manner they might be prompted to pour forth occasional ejaculations of public gratitude for public mercies; but it does not follow from these incidental occurrences that they would be led to institute times and places and forms of national worship, as if they believed the omniscient Deity more ready to hear them in public than in private. That the appointment of such times and forms and places is beneficial to society, experience teaches us; and therefore it is the duty, and has been the practice, of the supreme magistrate, in every age and in every civilized country, to provide for the maintenance of the national worship. But this practice has taken its rise, not from the deductions of reason, but either from direct revelation, as among the Jews and Christians; or from tradition, which had its origin in some early revelations, as among the more enlightened Pagans of ancient and modern times.

We hope none of our readers will imagine that we mean, in any degree, to call in question the fitness or the duty of public worship. This is far from our intention; but while we are convinced of the importance and necessity of this duty, we do not apprehend that we lessen its dignity, or detract from the weight of almost universal practice, by endeavouring to derive that practice from its true source, which appears to us to be not human reason, but divine revelation.

44 The practice of virtue a duty of natural religion.

But whatever doubts may be entertained with respect to the origin of public worship, there can be none as to the foundation of moral virtue. Reason clearly perceives it to be the will of our Maker, that each individual of the human race should treat every other individual as, in similar circumstances, he would expect to be treated himself. It is thus only that the greatest sum of human happiness can be produced (see MORAL PHILOSOPHY, N° 17. and 135.); for were all men temperate, sober, just in their dealings, faithful to their promises, charitable to the poor, &c. it is obvious that no miseries would be felt on earth, but the few which, by the laws of corporeal nature, unavoidably result from the union of our minds with systems of matter. But the design of God in forming sentient beings was to communicate to them some portion, or rather some resemblance, of that felicity which is essential to himself; and therefore every action which in its natural tendency co-operates with this design must be agreeable to him, as every action of a contrary tendency must be disagreeable.

From this reasoning it follows, that we are obliged not only to be just and beneficent to one another, but also to abstain from all unnecessary cruelty to inferior animals.

45 Cruelty to the inferior animals a sin.

That we have a right to tame cattle, and employ them for the purposes of agriculture and other arts where strength is required, is a position which we believe has seldom been controverted. But if it is the intention of God to communicate a portion of happiness to all his creatures endowed with sense, it is obvious that we sin against him when we subject even the horse or the ass to greater labour than he is able to perform; and this sin is aggravated when from avarice we give not the animal a sufficient quantity of food to support him under the exertions which we compel him to make. That it is our duty to defend ourselves and our property from the ravages of beasts of prey, and that we may even exterminate such beasts from the country in which we live, are truths which cannot be questioned; but it has been the opinion of men, eminent for wisdom and learning, that we have no right to kill an ox or a sheep for *food*, but in consequence of the divine permission to Noah recorded in the ninth chapter of the book of Genesis. Whether this opinion be well or ill founded we shall not positively determine, though the arguments on which it rests are of such a nature as the reasoners of the present day would perhaps find it no easy task to answer; but it cannot admit of a doubt, that, in killing such animals, we are, in duty to *their* Creator and *ours*, bound to put them to the least possible pain. If this be granted, it is still more evident

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evident that we act contrary to the divine will when we torture and put to death such animals as are confessedly not injurious to ourselves, or to any thing on which the comforts of life are known to depend. We are indeed far from being convinced with the poet, that insects and reptiles "in mortal sufferance feel as when a giant dies;" but their feelings on that occasion are certainly such, as that, when we wantonly inflict them, we thwart, as far as in our power, the benevolent purpose of the Creator in giving them life and sense. Let it be observed too, that the man who practises needless cruelty to the brute creation is training up his mind for exercising cruelty towards his fellow-creatures, to his slaves if he have any, and to his servants; and, by a very quick progress, to all who may be placed beneath him in the scale of society.

Such are the plain duties of natural religion; and if they were universally practised, it is evident that they would be productive of the greatest happiness which mankind could enjoy in this world, and that piety and virtue would be their own reward. They are however far from being universally practised; and the consequence is, that men are frequently raised to affluence and power by vice, and sometimes sunk into poverty by a rigid adherence to the rules of virtue.

This being the case, there can be no question of greater importance, while there are few more difficult to be answered, than, "What are the sanctions by which natural religion enforces obedience to her own laws?" It is not to be supposed that the great body of mankind should, without the prospect of an ample reward, practise virtue in those instances in which such practice would be obviously attended with injury to themselves; nor does it appear reasonable in any man to forego present enjoyment, without the well-grounded hope of thereby securing to himself a greater or more permanent enjoy-

46 Natural religion defective in its evidence of a future state.

ment in reversion. Natural religion therefore, as a system of doctrines influencing the conduct, is exceedingly defective, unless it affords sufficient evidence, intelligible to every ordinary capacity, of the immortality of the soul, or at least of a future state of rewards and punishments. That it *does* afford this evidence, is strenuously maintained by some deists, and by many philosophers of a different description, who, though they profess Christianity, seem to have some unaccountable dread of being deceived by their bibles in every doctrine which cannot be supported by philosophical reasoning.

47 The general expectation of a future state.

One great argument made use of to prove that the immortality of the soul is among the doctrines of natural religion, is the universal belief of all ages and nations that men continue to live in some other state after death has separated their souls from their bodies. "Quod si *omnium consensus naturæ vox est:* omnesque, qui ubique sunt, consentiunt esse aliquid, quod ad eos pertineat, qui vita cesserint: nobis quoque idem existimandum est: et si, quorum aut ingenio, aut virtute animus excellit, eos arbitramur, quia natura optima sunt, cernere naturæ vim maxime: verisimile est, *cum optimus quisque maxime posteritati serviat*, esse aliquid, cujus is post mortem sensum sint habiturus. Sed ut deos esse natura opinamur, qualesque sint, ratione cognoscimus, sic permanere animos arbitramur *consensu nationum omnium* *."

* Cicer. Tusc Quæst. lib. i. § 15, 15.

That this is a good argument for the truth of the doctrine, through whatever channel men may have received it, we readily acknowledge; but it appears not to us to be any proof of that doctrine's being the deduction of human reasoning. The popular belief of Paganism, both ancient and modern, is so fantastic and absurd, that it could never have been rationally inferred from what nature teaches of God and the soul. In the Elysium of the Greek and Roman poets, departed spirits were visible to mortal eyes; and must therefore have been clothed with some material vehicle of sufficient density to reflect the rays of light, though not to resist the human touch. In the mythology of the northern nations, as deceased heroes are represented as eating and drinking, they could not be considered as entirely divested of matter; and in every popular creed of idolatry, future rewards were supposed to be conferred, not for private virtue, but for public violence, on heroes and conquerors and the destroyers of nations. Surely no admirer of what is now called natural religion will pretend that these are part of its doctrines; they are evidently the remains of some primeval tradition obscured and corrupted in its long progress through ages and nations.

48 not the offspring of nature.

49 Opinions of the philosophers respecting a future state.

The philosophers of Greece and Rome employed much time and great talents in disquisitions concerning the human soul and the probability of a future state; and if the genuine conclusions of natural religion on this subject are anywhere to be found, one would naturally look for them in the writings of those men whose genius and virtues did honour to human nature. Yet it is a fact, that the philosophers held such notions concerning the substance of the soul and its state after death as could afford no rational support to suffering virtue, (see METAPHYSICS, Part III. chap. 4.). Socrates is indeed an exception. Confining himself to the study of ethics, that excellent person inferred by the common moral arguments (see MORAL PHILOSOPHY, N°232—246.), that the reality of a future state of rewards and punishments is in the highest degree probable. He was not, however, at all times absolutely *convinced* of this important truth; for a little before his death he said to some who were about him, "I am now about to leave this world, and ye are still to continue in it; which of us have the better part allotted us, God only knows *." And again, at the end of his most admired discourse concerning the immortality of the soul, delivered at a time when he must have been serious, he said to his friends who came to pay their last visit, "I would have you to know that I have great hopes that I am now going into the company of good men; yet I would not be too peremptory and confident concerning it †."

* *Plato in Apolog. Soc.*

† *Plato in Phæd.*

Next to Socrates, Cicero was perhaps the most respectable of all the philosophers of antiquity; and he seems to have studied this great question with uncommon care: yet what were his conclusions? After retailing the opinions of various sages of Greece, and showing that some held the soul to be the *heart*; others, the *blood* in the heart; some the *brain*; others, the *breath*; one, that it was *harmony*; another, that it was *number*; one, that it was *nothing* at all; and another, that it was a certain *quintessence* without a name, but which might properly be called ἐντελέχεια—he gravely adds, "Harum sententiarum quæ vera sit, Deus aliquis viderit: que verisimillima, magna questio est ‡." He then proceeds to give his own opinion; which was, that the soul was part of God.

‡ *Tusc. Quæst.* lib. i. § 9, 10, 11.

To us who know by other evidence that the soul is immortal, and that there will be a future state in which

all.

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all the obliquities of the present shall be made straight, the argument drawn from the moral attributes of God, and the unequal distribution of the good things of this life, appears to have the force of demonstration. Yet none of us will surely pretend to say that his powers of reasoning are greater than were those of Socrates and Cicero: and therefore the probability is, that had we been like them destitute of the light of revelation, we should have been disturbed by the same doubts, and have said with the latter, on reading the arguments of the former as detailed by Plato, "Nescio quomodo, dum lego, assentior: cum posui librum, et mecum ipse de immortalitate animorum cœpi cogitare, assensio illa elabitur †."

† *Ibid.*

50 Without the light of revelation we should have doubted like them.

No one, we hope, will suspect us of an impious attempt to weaken the evidence of a future state. God forbid! The expectation of that state is the only support of virtue and religion; and we think the arguments we have stated elsewhere, and referred to on the present occasion, make the reality of it so highly probable, that, though there were no other evidence, he would act a very foolish part who should confine his attention wholly to the present life. But we do not apprehend that we can injure the cause either of virtue or of religion, by confessing, that those arguments which left doubts in the minds of Socrates and Cicero appear not to us to have the force of *complete demonstration* of that life and immortality which our Saviour brought to light through the gospel.

51 Natural religion has no means of certainly reconciling the Deity to sinners.

Were the case, however, otherwise; were the arguments which the light of nature affords for the immortality of the human soul as convincing as any geometrical demonstration—natural religion would still be defective; because it points out no method by which such as have offended God may be restored to his favour and to the hopes of happiness which by their sin they had lost. That he who knows whereof we are made would show himself placable to sinners, and that he would find some way to be reconciled, might perhaps be reasonably inferred from the consideration of his benevolence displayed in his works. But when we come to inquire more particularly *how* we are to be reconciled, and whether a *propitiation* will be required, *nature* stops short, and expects with impatience the aid of some particular revelation. That God will receive returning sinners, and accept of repentance instead of perfect obedience, cannot be certainly known by those to whom he has not *declared* that he will. For though repentance be the most probable, and indeed the only means of reconciliation which nature suggests; yet whether he, who is of purer eyes than to behold iniquity, will not require something further before he restores sinners to the privileges which they have forfeited, mere human reason has no way of discovering. From nature therefore arises no sufficient comfort to sinners, but anxious and endless solicitude about the means of appeasing the Deity. Hence those different ways of sacrificing, and those numberless superstitions which overspread the heathen world, but which were so little satisfactory to the wiser part of mankind, that, even in those days of darkness, the philosophers frequently declared that, in their opinion, those rites and oblations could avail nothing towards appeasing the wrath of an offended God, or making their prayers acceptable to him. Hence Socrates and one of his disciples are represented by Plato ‡ as expecting a person divinely commissioned to inform them whether sacrifices be acceptable to the deity, and as resolving to offer no more till that person's arrival, which they piously hoped might be at no great distance.

‡ *In Alcibiade.*

52 These doubts removed by the Scriptures.

This darkness of the pagan world is to us who live under the sunshine of the gospel happily removed by the various revelations contained in the scriptures of the Old and New Testaments. These taken together exhibit such a display of providence, such a system of doctrines, and such precepts of practical wisdom, as the ingenuity of man could never have discovered. The Christian, with the scriptures in his hands, can regulate his conduct by an infallible guide, and rest his hopes on the surest foundation. These scriptures it is now our business to examine.

PART II. OF REVEALED THEOLOGY.

53 Many pretences to revelation,

IN every civilized country the popular system of theology has claimed its origin from divine revelation. The Pagans of antiquity had their augurs and oracles; the Chinese have their inspired teachers Confucius and Fohi: the Hindoos have their sacred books derived from Brahma; the followers of Mahomet have their Koran dictated by an angel; and the Jews and Christians have the Scriptures of the Old and New Testaments, which they believe to have been written by holy men of old, who spake and wrote as they were moved by the Holy Ghost.

54 though the Jewish and Christian revelations are alone true.

That the claims of ancient Paganism to a theology derived from heaven, as well as the similar claims of the Chinese, Hindoos, and Mahometans, are ill founded, has been shown in various articles of this work, (see CHINA, HINDOSTAN, MAHOMETANISM, MYTHOLOGY, and POLYTHEISM); whilst under the words RELIGION, REVELATION, and SCRIPTURE, we have sufficiently proved the divine inspiration of the Jewish and Christian scriptures, and of course the divine origin of Jewish and Christian theology. These indeed are not two systems of theology, but parts of one system which was gradually revealed as men were able to receive it; and therefore both scriptures must be studied by the Christian divine.

There is nothing in the sacred volume which it is not of importance to understand; for the whole proceeds from the fountain of truth: but some of its doctrines are much more important than others, as relating immediately to man's everlasting happiness; and these it has been customary to arrange and digest into regular systems, called *bodies* or *institutes* of *Christian theology*. Could these artificial systems be formed with perfect impartiality, they would undoubtedly be useful, for the bible contains many historical details, but remotely related to salvation; and even of its most important truths, it requires more time and attention than the majority of Christians have to bestow, to discover the mutual connection and dependence.

55 Common divisions of revealed theology.

Artificial systems of theology are commonly divided into two great parts, the *theoretic* and the *practical*; and

Revealed Theology. and these again are subdivided into many inferior branches. Under the theoretic part are sometimes classed,

1. *Dogmatic* theology; which comprehends an entire system of all the dogmas or tenets which a Christian is bound to believe and profess. The truth of these the divine must clearly perceive, and be able to enforce on his audience: and hence the necessity of studying what is called,

2. The *exegesis*, or the art of attaining the true sense of the holy scriptures; and,

3. *Hermeneutic* theology, or the art of interpreting and explaining the scriptures to others; an art of which no man can be ignorant who knows how to attain the true sense of them himself.

4. *Polemical* theology, or controversy; and,

5. *Moral* theology, which is distinguished from moral philosophy, or the simple doctrine of ethics, by teaching a much higher degree of moral perfection than the mere light of reason could ever have discovered, and adding new motives to the practice of virtue.

The practical sciences of the divine are,

1. *Homiletic* or *pastoral* theology; which teaches him to adapt his discourses from the pulpit to the capacity of his hearers, and to pursue the best methods of guiding them by his doctrine and example in the way of salvation.

2. *Catechetic* theology, or the art of teaching youth and ignorant persons the principal points of evangelical doctrine, as well with regard to belief as to practice.

3. *Casuistic* theology, or the science which decides on doubtful cases of moral theology, and that calms the scruples of conscience which arise in the Christian's soul during his journey through the present world.

We have mentioned these divisions and subdivisions of the science of theology, not because we think them important, but merely that our readers may be at no loss to understand the terms when they meet with them in
56 Useless. other works. Of such terms we shall ourselves make no use, for the greater part of them indicate distinctions where there is no difference, and tend only to perplex the student. As the truths of Christianity are all contained in the scriptures of the Old and New Testaments, it is obvious that dogmatic theology must comprehend the speculative part of that which is called moral, as well as every doctrine about which controversy can be of importance. But no man can extract a single dogma from the bible but by the practice of what is here called the *exegesis*; so that all the subdivisions of this arrangement of theoretical theology must be studied together as they necessarily coalesce into one. The same thing is true of the three branches into which practical theology is here divided. He who has acquired the art of adapting his homilies to the various capacities of a mixed audience, will need no new study to fit him for instructing children, and the most ignorant persons who are capable of instruction; and the complete master of moral theology will find it no very difficult task to resolve all the cases of conscience which he can have reason to suppose will ever be submitted to his judgment. For these reasons we shall not trouble our readers with the various divisions and subdivisions of theology. Our preliminary directions will show them how we think the science should be studied; and all that we have to do as *system-builders* is to lay before them the view which the scriptures present to us of the being and perfections of God, his various dispensations to man, and the duties thence incumbent on Christians. In doing this, we shall follow the order of the divine dispensations as we find them recorded in the Old and New Testaments, dwelling longest on those which appear to us of most general importance. But as we take it for granted that every reader of this article will have previously read the whole sacred volume, we shall not scruple to illustrate dogmas contained in the Old Testament by texts taken from the New, or to illustrate doctrines peculiar to the Christian religion by the testimony of Jewish prophets.

God and his Attributes.

Sect. I. *Of God and his Attributes.*

57 The first revelation supposes the being of God to be a known truth.

In every system of theology the first truths to be believed are those which relate to the being and attributes of God. The Jewish lawgiver, therefore, who records the earliest revelations that were made to man, begins his history with a display of the power and wisdom of God in the creation of the world. He does not inform his countrymen, and expect them to believe, on the authority of his divine commission, that God *exists*; for he well knew that the being of God must be admitted, and just notions entertained of his attributes, before man can be required to pay any regard to miracles which afford the only evidence of a primary revelation. "In the beginning (says he) God created the heavens and the earth." Here the being of God is assumed as a truth universally received; but the sentence, short as it is, reveals another, which, as we shall afterwards shew, human reason could never have discovered.

There is nothing which the scriptures more frequently or more earnestly inculcate than the unity of the divine nature. The texts asserting this great and fundamental truth are almost numberless. "Unto thee (says Moses to his countrymen*) it was shewed, that thou mightest know that the Lord is God; there is *none else besides him*. Know therefore that the Lord *he is God* in *heaven above* and upon the *earth beneath: there is none else*." And again, "Hear, O Israel, the Lord our God is *one Lord*," or, as it is expressed in the original, "Jehovah our God is one Jehovah," one Being to whom existence is essential, who could not have a beginning and cannot have an end. In the prophecies of Isaiah, God is introduced as repeatedly declaring †, "I am Jehovah, and there is *none else*; there is *no God besides me*: that they may know from the rising of the sun and from the west, that there is *none besides me*: I am *Jehovah*, and there is *none else*: Is there a God besides me? Yea there is *no God*; I know not any." In perfect harmony with these declarations of Moses and the prophets, our Saviour, addressing himself to his Father, says ‡, "This is life eternal, that they might know *Thee, the only true God*, and Jesus Christ whom Thou hast sent;" and St Paul, who derived his doctrine from his divine Master, affirms §, that "an idol is nothing in the world; and that there is *none other God but one*."

* Deut. iv. 35, and 39, vi. 4.

† Isaiah xlv. 5, 6, 18, xliv. 8.

‡ John xvii. 3.

§ 1 Cor. viii. 4.

The unity of the divine nature, which, from the order and harmony of the world, appears probable to human reason, these texts of revelation put beyond a doubt. Hence the first precept of the Jewish law, and, according to their own writers, the foundation of their whole religion, was, "Thou shalt have none other gods before Me."

God and his Attributes.

Me." Hence, too, the reason of that strict command to Jews and Christians to give divine worship to none but God: "Thou shalt worship the Lord thy God, and him only shalt thou serve;" because he is *God alone*. Him only must we fear, because he alone hath infinite power; in him alone must we trust, because "he only is our rock and our salvation;" and to him alone must we direct our devotions, because "he only knoweth the hearts of the children of men."

58
Denotes a plurality of persons in the Godhead

The word אלהים does not indicate a plurality of gods. In the opinion, however, of many eminent divines, it denotes, by its junction with the singular verb, a plurality of persons in the one Godhead; and some few have contended, that by means of this peculiar construction, the Christian doctrine of the Trinity may be proved from the first chapter of the book of Genesis. To this latter opinion we can by no means give our assent. That there are three distinct persons in the one divine nature may be inferred with sufficient evidence from a multitude of passages in the Old and New Testaments diligently compared together; but it would perhaps be rash to rest the proof of so sublime a mystery on any single text of holy scripture, and would certainly be so to rest it on the text in question. That Moses was acquainted with this doctrine, we may reasonably conclude from his so frequently making a plural name of God to agree with a verb in the singular number; but had we not possessed the brighter light of the New Testament to guide us, we should never have thought of drawing such an inference. For supposing the word אלהים to denote clearly a plurality of persons, how could we have known that the number is neither more or less than three, had it not been ascertained to us by subsequent revelations?

There are indeed various passages in the Old Testament, of the phraseology of which no rational account can be given, but that they indicate more than one person in the Godhead. Such are those texts already noticed; "and the Lord God said, let US make man in OUR own image, after OUR likeness;" and "the Lord God said, behold the man is become like ONE of US." To these may be added the following, which are to us perfectly unintelligible on any other supposition; and "the Lord God said, let US go down, and there confound their language *." "If I be a *Master* (in the Hebrew *adonim*, MASTERS), where is my fear †?" "The fear of the Lord (JEHOVAH) is the beginning of wisdom, and the knowledge of the Holy (in the Hebrew HOLY ONES) is understanding ‡." "Remember thy Creator (Hebrew, thy CREATORS) in the days of thy youth §." "And now the LORD GOD and his SPIRIT hath sent me ||." "Seek ye out of the book of the LORD and read; for MY mouth it hath commanded, and his SPIRIT it hath gathered them *."

* Gen. xi. 6, 7.
† Mal. i. 6.
‡ Prov. ix. 10.
§ Eccl. xii. 1.
|| Isaiah xlviii. 16.
* Isaiah xxxiv. 16.

That these texts imply a plurality of divine persons, seems to us incontrovertible. When Moses represents God as saying, let us make man, the majesty of the plural number had not been adopted by earthly sovereigns; and it is obvious that the Supreme Being could not, as has been supposed, call on angels to make man; for in different places of scripture † creation is attributed to God alone. Hence it is that Solomon speaks of Creators in the *plural number*, though he means only the one Supreme Being, and exhorts men to remember them in the days of their youth. In the passage first quoted from Isaiah, there is a distinction made between the *Lord God* and his *Spirit*; and in the other, three divine persons are introduced, viz. the *Speaker*, the *Lord*, and the *Spirit* of the Lord. It does not, however, appear evident from these passages, or from any other that we recollect in the Old Testament, that the persons in Deity are three and no more: but no sober Christian will harbour a doubt but that the precise number was by some means or other made known to the ancient Hebrews; for inquiries leading to it would be naturally suggested by the form in which the high priest was commanded to bless the people. "The LORD bless thee and keep thee. The LORD make his face to shine upon thee, and be gracious unto thee. The LORD lift up his countenance upon thee, and give thee peace *."

† Job ix. 8. Isa. xlv. *passim.*

* Numb. vi. 24, 25, 26.

59
A Trinity in unity the doctrine of scripture.

The form of Christian baptism establishes the truth of the doctrine of the Trinity beyond all reasonable ground of dispute. "Go (says our blessed Saviour) and teach all nations, baptizing them in the name of the Father, and of the Son, and of the Holy Ghost." What was it the apostles were to teach all nations? Was it not to turn from their vanities to the living God; to renounce their idols and false gods, and so to be baptized in the name of the Father, and of the Son, and of the Holy Ghost? What now must occur to the Gentile nations on this occasion, but that, instead of all their deities, to whom they had before bowed down, they were in future to serve, worship, and adore, Father, Son, and Holy Ghost, as the only true and living God? To suppose that GOD and TWO CREATURES are here joined together in the solemn rite by which men were to be admitted into a new religion, which directly condemns all *creature-worship*, would be so unreasonable, that we are persuaded such a supposition never was made by any converted Polytheist of antiquity. The nations were to be baptized in the name of three persons, in the *same manner*, and therefore, doubtless, in the *same sense*. It is not said in the name of GOD and his two faithful *servants*; nor in the name of GOD, and CHRIST, and the HOLY GHOST, which might have suggested a thought that *one* only of the three is God; but in the name of the FATHER, and of the SON, and of the HOLY GHOST. Whatever honour, reverence, or regard, is paid to the first person in this solemn rite, the same is paid to all three. Is he acknowledged as the object of worship? So are the other two likewise. Is he God and Lord over us? So are they. Are we enrolled as subjects, servants, and soldiers, under him? So are we equally under all. Are we hereby regenerated and made the temple of the Father? So are we likewise of the Son and Holy Ghost. "We will come (says our Saviour †) and make our abode with him."

† John xiv. 23.

If those who believe the inspiration of the scriptures could require any further proof that the Godhead comprehends a trinity of persons in one nature, we might urge the apostolical form of benediction; "The grace of our LORD JESUS CHRIST, and the love of GOD, and the communion of the HOLY GHOST, be with you all ‡." Would St Paul, or any other man of common sense, have in the same sentence, and in the most solemn manner, recommended his Corinthian converts to the love of God, and to the grace and communion of two creatures? We should think it very absurd to recommend a man at once to the favour of a king and a beggar;

‡ 2 Cor. xiii. 14.

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gar; but how infinitely small is the distance between the greatest earthly potentate and the meanest beggar, when compared with that which must for ever subsist between the Almighty Creator of heaven and earth and the most elevated creature?

60
Difficulties in this doctrine.

But how, it will be asked, can three divine persons be but one and the same God? This is a question which has been often put, but which, we believe, no created being can fully answer. The divine nature and its manner of existence is, to us, wholly incomprehensible; and we might with greater reason attempt to weigh the mountains in scales, than by our limited faculties to fathom the depths of infinity. The Supreme Being is present in power to every portion of space, and yet it is demonstrable, that in his essence he is not extended (see METAPHYSICS, N° 309, 310). Both these truths, his inextension and omnipresence, are fundamental principles in what is called *natural religion;* and when taken together they form, in the opinion of most people, a mystery as incomprehensible as that of the Trinity in unity. Indeed there is nothing of which it is more difficult to form a distinct notion than *unity* simple, and absolutely indivisible. Though the Trinity in unity, therefore, were no Christian doctrine, mysteries must still be believed; for they are as inseparable from the religion of nature as from that of revelation; and atheism involves the most incomprehensible of all mysteries, even the beginning of existence without a cause. We must indeed form the best notions that we can of this and all other myteries; for if we have no notions whatever of a Trinity in unity, we can neither believe nor disbelieve that doctrine. It is however to be remembered, that all our notions of God are more or less analogical; that they must be expressed in words which, literally interpreted, are applicable only to man; and that propositions understood in this literal sense may involve an apparent contradiction, from which the truth meant to be expressed by them would be seen to be free, had we direct and adequate conceptions of the divine nature. On this account it is to be wished that men treating of the mystery of the Holy Trinity, had always expressed themselves in scripture language, and never aimed at being wise above what is written; but since they have acted otherwise, we must, in justice to our readers, animadvert on one or two statements of this doctrine, which we have reason to believe are earnestly contended for by some who consider themselves as the only orthodox.

In the scriptures, the three persons are denominated by the terms FATHER, SON, and HOLY GHOST, or by GOD, the WORD, who is also declared to be God, and the SPIRIT OF GOD. If each be truly God, it is obvious that they must all have the same divine nature, just as every man has the same human nature with every other man; and if there be but ONE GOD, it is equally obvious that they must be of the same individual substance or essence, which no three men can possibly be. In this there is a difficulty; but, as will be seen by and by, there is no contradiction. The very terms FATHER and SON imply such a relation between the two persons so denominated, as that though they are of the same substance, possessed of the same attributes, and equally God, just as a human father and his son are equally men, yet the second must be personally subordinate to the first. In like manner, the HOLY GHOST, who is called the Spirit of God, and is said to *proceed from* the *Father*, and to be *sent* by the *Son*, must be conceived as subordinate to both, much in the same way as a son is subordinate to his parents, though possessed of equal or even of superior powers. That this is the true doctrine, appears to us undeniable from the words of our Saviour himself, who, in a prayer addressed to his Father, styles him * by way of pre-eminence, "the only true God," as being the fountain or origin of the Godhead from which the Son and the Holy Ghost derive their true divinity. In like manner, St Paul, when opposing the polytheism of the Greeks, says expressly †, that "to us there is but one God, THE FATHER, OF whom are all things, and we in, or for, him; and one LORD JESUS CHRIST, BY whom are all things, and we by him."

61
Subordination of the second and third persons.

* John xvii. 3.

† 1 Cor. viii. 6.

That the primitive fathers of the Christian church maintained this subordination of the second and third persons of the blessed Trinity to the first, has been evinced with complete evidence by Bishop Bull. We shall transcribe two quotations from him, and refer the reader for fuller satisfaction to *sect.* 4. of his *Defensio fidei Nicenæ*. The first shall be a passage cited from *Novatian*, in which the learned prelate assures us the sense of all the ancients is expressed. "Quia quid est Filius, non ex se est, quia nec innatus est; sed ex patre est, quia genitus est: sive dum verbum est, sive dum virtus est, sive dum sapientia est, sive dum lux est, sive dum Filius est, et quicquid horum est, non aliunde est quam ex Patre, Patri suo originem suam debens." The next is from Athanasius, who has never been accused of holding low opinions respecting the second person of the holy Trinity. This father, in his fifth discourse against the Arians, says, κατα γαρ τον Ιωαννην εν ταυτη τη αρχη ην ὁ λογος και ὁ λογος, ην προς τον θεον. Θεος γαρ εστιν ἡ αρχη, και επειδαν εξ αυτης εστι, δια τουτο και θεος ην ὁ λογος; *according to John, the Word was in this first principle, and the Word was God. For God is the principle; and because the Word is from the principle, therefore the Word is God.* Agreeably to this doctrine, the Nicene fathers, in the creed which they published for the use of the universal church, style the only begotten Son, GOD OF GOD, θεος εκ θεου.

62
Denied by some modern divines, but

Regardless however of antiquity, and of the plain sense of scripture, some modern divines of great learning contend, that the three persons in Deity are all *consubstantial*, *co-eternal*, *co-ordinate*, without *derivation*, *subordination*, or *dependence*, of *any sort*, as to nature or essence; while others affirm, that the second and third persons derive from the first their personality, but not their nature. We shall consider these opinions as different, though, from the obscurity of the language in which we have always seen them expressed, we cannot be certain but they may be one and the same. The maintainers of the former opinion hold, that the three persons called *Elohim* in the Old Testament, naturally independent on each other, entered into an agreement before the creation of the world, that one of them should in the fulness of time assume human nature, for the purpose of redeeming mankind from that misery into which it was foreseen that they would fall. This antemundane agreement, they add, constitutes the whole of that paternal and filial relation which subsists between the first and second persons whom we denominate Father and Son; and they hold, that the Son is said to be begotten before all worlds, to indicate that *He* who was before all worlds was *begotten*, or to *be* begotten, into the office of of redeemer; or, more decisively, to signify that he undertook that office before the creation, and *assumed* to himself some appearance or figure of the reality in which he was to execute it; and he is called μονογενης, or the only begotten, because he *alone* was begotten into the office of redeemer *.

* See *Ridgeley's Body of Divinity.*

63 The express doctrine of scripture.

To many of our readers we doubt not but this will appear a very extraordinary doctrine, and not easy to be reconciled with the unity of God. It is however sufficiently overturned by two sentences of holy scripture, about the meaning of which there can be no dispute. "In this (says St John †) was manifested the love of God towards us, because that God sent his only begotten Son into the world, that we might live through him." Taking the word *son* in its usual acceptation, this was certainly a wonderful degree of love in the Father of mercies to send into the world on our account a person so near related to him as an only son; but if we substitute this novel interpretation of the words *only begotten son* in their stead, the apostle's reasoning will lose all its force. St John will then be made to say, "In this was manifested the love of God toward us, because that God sent a divine person equal to himself, and no way related to him, but who had before the creation covenanted to come into the world, that we might live through him." Is this a proof of the love of the person here called God? Again, the inspired author of the epistle to the Hebrews, treating of our Saviour's priesthood, says, among other things expressive of his humiliation, that "though he was a SON, yet learned he obedience by the things which he suffered ‡." If the word *son* be here understood in its proper sense, this verse displays in a very striking manner the condescension of our divine Redeemer, who, though he was no less a person than the proper Son of God by nature, yet vouchsafed to learn obedience by the things which he suffered; but if we substitute this metaphorical sonship in place of the natural, the reasoning of the author will be very extraordinary. "Though this divine personage agreed before all worlds to suffer death for the redemption of man, yet learned he obedience by the things which he suffered." What sense is there in this argument? Is it a proof of condescension to fulfil one's engagement? Surely, if the meaning of the word *son*, when applied to the second person of the blessed Trinity, were what is here supposed, the inspired writer's argument would have been more to the purpose for which it is brought, had it run thus: "Though he was *not* a son, i. e. though he had made no previous agreement, yet condescended he to learn," &c.

† John iv. 9.

‡ Heb. v. 8.

The other opinion, which supposes the Son and the Holy Ghost to derive from the Father their personality, but not their nature, is to us wholly unintelligible; for personality cannot exist, or be conceived in a state of separation from all natures, any more than a quality can exist in a state of separation from all substances. The former of these opinions we are unable to reconcile with the unity of God; the latter is clothed in words that have no meaning. Both as far as we can understand them, are palpable polytheism; more palpable indeed than that of the Grecian philosophers, who though they worshipped gods many, and lords many, yet all held one God supreme over the rest. See POLYTHEISM, N° 32.

But if the Son and the Holy Ghost derive their nature as well as their personality from the Father, will it not follow that they must be posterior to him in time, since every effect is posterior to its cause? No; this consequence seems to follow only by reasoning too closely from one nature to another, when there is between the two but a very distant analogy. It is indeed true, that among men, every father must be prior in time as well as in the order of nature to his son; but were it essential to a man to be a father, so as that he could not exist otherwise than in that relation, it is obvious that his son would be coeval with himself, though still as proceeding from him, he would be posterior in the order of nature. This is the case with all necessary causes and effects. The visible sun is the immediate and necessary cause of light and heat, either as emitting the rays from his own substance, or as exciting the agency of a fluid diffused for that purpose through the whole system. Light and heat, therefore, must be as old as the sun; and had he existed from eternity, they would have existed from eternity with him, though still, as his effects, they would have been behind him in the order of nature. Hence it is, that as we must speak analogically of the Divine nature, and when treating of mind, even the Supreme mind, make use of words literally applicable only to the modifications of matter, the Nicene fathers illustrate the eternal generation of the second person of the blessed Trinity by this procession of light from the corporeal sun, calling him *God OF God, light OF light.*

64 The second and third persons not posterior to the first.

Another comparison has been made use of to enable us to form some notion, however inadequate, how three Divine persons can subsist in the same substance, and thereby constitute but one God. Moses informs us, that man was made after the image of God. That this relates to the soul more than to the body of man, has been granted by all but a few gross anthropomorphites; but it has been well observed *, that the soul, though in itself one indivisible and unextended substance, is conceived as consisting of three principal faculties, the *understanding*, the *memory*, and the *will*. Of these, though they are all coeval in time, and equally essential to a rational soul, the understanding is in the order of nature obviously the first, and the memory the second; for things must be perceived before they can be remembered; and they must be remembered and compared together before they can excite volitions, from being some agreeable, and others disagreeable. The memory therefore may be said to spring from the understanding, and the will from both; and as these three faculties are conceived to constitute one soul, so may three Divine persons partaking of the same individual nature or essence constitute one God.

* *Leslie's Socinian Controversy.*

65 No contradiction in the Catholic doctrine of the Trinity.

These parallels or analogies are by no means brought forward as proofs of the Trinity, of which the evidence is to be gathered wholly from the word of God; but they serve perhaps to help our labouring minds to form the justest notions of that mystery which it is possible for us to form in the present state of our existence; and they seem to rescue the doctrine sufficiently from the charge of contradiction, which has been so often urged against it by Unitarian writers. To the last analogy we are aware it has often been objected, that the soul may as well be said to consist of ten or twenty faculties as of three, since the passions are equally essential to it with the understanding, the memory, and the will, and are as different from one another as these three faculties are.

This,

This, however, is probably a mistake; for the best philosophy seems to teach us, that the passions are not innate; that a man might exist through a long life a stranger to many of them; and that there are probably no two minds in which are generated *all* the passions (see PASSION); but understanding, memory, and will, are absolutely and equally necessary to every rational being. But whatever be in this, if the human mind can be *conceived* to be one indivisible substance, consisting of different faculties, whether many or few, why should it be thought an impossibility for the infinite and eternal nature of God to be communicated to three persons acting different parts in the creation and government of the world, and in the great scheme of man's redemption.

66 Objections.

To the doctrine of the Trinity many objections have been made, as it implies the divinity of the Son and the Holy Ghost; of whom the former assumed our nature, and in it died for the redemption of man. These we shall notice when we come to examine the revelations more peculiarly Christian; but there is one objection which, as it respects the doctrine in general, may be properly noticed here. It is said that the first Christians borrowed the notion of a Triune God from the later Platonists; and that we hear not of a Trinity in the church till converts were made from the school of Alexandria. But if this be the case, we may properly ask, whence had those Platonists the doctrine themselves? It is not surely so simple or so obvious as to be likely to have occurred to the reasoning mind of a Pagan philosopher; or if it be, why do Unitarians suppose it to involve a contradiction? Plato indeed taught a doctrine in some respects similar to that of the Christian Trinity, and so did Pythagoras, with many other philosophers of Greece and the East (see PLATONISM, POLYTHEISM, and PYTHAGORAS); but though these sages appear to have been on some occasions extremely credulous, and on others to have indulged themselves in the most mysterious speculations, there is no room to suppose that they were *naturally weaker men* than ourselves, or that they were capable of inculcating as truths what they *perceived* to involve a *contradiction*. The Platonic and Pythagorean trinities never could have occurred to the mind of him who merely from the works of creation endeavoured to discover the being and attributes of the Creator; and therefore as those philosophers travelled into Egypt and the East in quest of knowledge, it appears to us in the highest degree probable, that they picked up this mysterious and sublime doctrine in those regions where it had been handed down as a dogma from the remotest ages, and where we know that science was not taught systematically, but detailed in collections of

67 Answered.

sententious maxims and traditionary opinions. If this be so, we cannot doubt but that the Pagan trinities had their origin in some primæval revelation. Nothing else indeed can account for the general prevalence of a doctrine so remote from human imagination, and of which we find vestiges in the sacred books of almost every civilized people of antiquity. The corrupt state in which it is viewed in the writings of Plato and others, is the natural consequence of its descent through a long course of oral tradition; and then falling into the hands of men who bent every opinion as much as possible to a conformity with their own speculations. The trinity of Platonism therefore, instead of being an objection, lends, in our opinion, no feeble support to the Christian doctrine, since it affords almost a complete proof of that doctrine's having made part of the first revelations communicated to man.

Having thus discovered that the one God comprehends three persons, let us now inquire what this triune God exerted when he created the heaven and the earth. That by the heaven and the earth is here meant the whole universe, visible and invisible, is known to every person acquainted with the phraseology of Scripture; and we need inform no man conversant with English writers, that by *creation*, in its proper sense, is meant bringing into *being* or making that to *exist* which existed not *before*. It must, however, be acknowledged, that the Hebrew word ברא does not always imply the production of substance, but very often the forming of particular organized bodies out of pre-existing matter. Thus when it is said* that "God *created* great whales, and every living creature that moveth, which the waters brought forth abundantly after their kind," and again, "that he *created* man male and female;" though the word ברא is used on both occasions, we are not to conceive that the bodies of the first human pair, and of these animals, were brought into being from nonentity, but only that they were formed by a proper organization being given to pre-existent matter. But when Moses says, "In the beginning God *created* the heaven and the earth," he cannot be supposed to mean, that "in the beginning God only gave form to matter already existing of itself;" for in the very next verse we are assured that after this act of creation was over, "the earth was still *without form* and void," or, in other words, in a chaotic state.

68 Creation taught by Moses.

That the Jews, before the coming of our Saviour, understood their lawgiver to teach a proper creation, is plain from that passage in the second book of the Maccabees, in which a mother, to persuade her son to suffer the cruellest tortures rather than forsake the law of his God, uses the following argument: "I beseech thee, my son, look upon the heaven and the earth, and all that is therein, and consider that God made them of things that were not." To the same purpose the inspired author of the epistle to the Hebrews, when magnifying the excellence of faith, says, "Through faith we understand that the worlds were framed by the word of God, so that things which are seen were not made of things which do appear;" where, as Bishop Pearson has ably proved †, the phrase μη εκ φαινομενων is equivalent to ουκ εξ οντων, in the quotation from the Maccabees.

The very first verse, therefore, of the book of Genesis informs us of a most important truth, which all the uninspired wisdom of antiquity could not discover. It assures us, that as nothing exists by chance, so nothing is necessarily existing but the three divine persons in the one Godhead. Every thing else, whether material or immaterial, derives its substance, as well as its form or qualities, from the fiat of that self-existent Being, "who was, and is, and is to come."

69 The whole universe not created at once.

It does not, however, follow from this verse, or from any other passage in the sacred Scriptures, that the whole universe was called into existence at the same instant; neither is it by any means evident that the chaos of our world was brought into being on the first of those six days during which it was gradually reduced into form. From a passage ‡ in the book of Job, in which we are told by God himself, that when the "foundation of the earth

* Gen. i. 21, 27.

† Exposition of the Creed.

‡ xxxviii. 7.

God and his Attributes.

earth was laid the morning stars sang together, and all the sons of God shouted for joy," it appears extremely probable that worlds had been created, formed, and inhabited, long before our earth had any existence. Nor is this opinion at all contrary to what Moses says of the creation of the stars; for though they are mentioned in the same verse with the sun and moon, yet the manner in which, according to the original, they are introduced, by no means indicates that all the stars were formed at the same time with the luminaries of our system. Most of them have been created long before, and some of them since, our world was brought into being; for that clause (ver. 16.) "he made the stars also," is in the Hebrew no more than "and the stars;" the words *he made* being inserted by the translators. The word verse therefore ought to be rendered thus, "and God made two great lights; the greater light to rule the day, and the lesser light with the stars to rule the night; where nothing is intimated with respect to the *time* when the stars were formed, any more than in that verse of the Psalms *, which exhorts us to give thanks to God who made the moon and stars to rule by night; for his mercy endureth "for ever." The first verse of the book of Genesis informs us that all things spiritual and corporeal derive their existence from God; but it is nowhere said that all matter was created at the same time.

* Psalm cxxxvi. 9.

That the whole corporeal universe *may have been* created at once must be granted; but if so, we have reason to believe that this earth, with the sun and all the planets of the system, were suffered to remain for ages in a state of chaos, "without form and void;" because it appears from other scriptures, that worlds of intelligent creatures existed, and even that some angels had fallen from a state of happiness prior to the era of the Mosaic cosmogony. That the sun and the other planets revolving round him were formed at the same time with the earth, cannot indeed be questioned; for it is not only probable in itself from the known laws of nature, but is expressly affirmed by the sacred historian, who relates the formation of the sun and moon in the order in which it took place; but there is one difficulty which has furnished ignorance with something like an objection to the divine legation of the Hebrew lawgiver, and which we shall notice.

70 The solar system created at once.

71 A difficulty solved.

Moses informs us, that on the *first day* after the production of the chaos, the *element of light* was created; and yet within a few sentences he declares, that the sun, the fountain of light, was not made till the *fourth day*. How are these two passages to be reconciled? We answer, That they may be reconciled many ways. Moses wrote for the use of a whole people, and not for the amusement or instruction of a few astronomers; and in this view his language is sufficiently proper, even though we suppose the formation of the sun and the other planets to have been carried on at the same time, and in the same progressive manner, with the formation of this earth. The voice which called light into existence would separate the fiery and luminous particles of the chaos from those which were opaque, and, on this hypothesis, consolidate them in one globe, diffusing an obscure light through the planetary system; but if the earth's atmosphere continued till the fourth day loaded with vapours, as from the narrative of Moses it appears to have done, the sun could not till *that day* have been *seen* from the earth, and may therefore, in popular language, be said with sufficient propriety to have been *formed* on the fourth day, as it was then made to *appear*. (See CREATION, N° 13.) But though this solution of the difficulty serves to remove the objection, and to secure the credit of the sacred historian, candour compels us to confess that it appears not to be the true solution.

The difficulty itself arises entirely from supposing the sun to be the sole fountain of light; but the truth of this opinion is not self-evident, nor has it ever been established by satisfactory proof. It is indeed to a mind divested of undue deference to great names, and considering the matter with impartiality, an opinion extremely improbable. The light of a candle placed on an eminence may in a dark night be seen in every direction at the distance of at least three miles. But if this small body be rendered visible by means of rays emitted from itself, the flame of a candle, which cannot be supposed more than an inch in diameter, must, during every instant that it continues to burn, throw from its own substance luminous matter sufficient to fill a spherical space of six miles in diameter. This phenomenon, if real, is certainly surprising; but if we pursue the reflection a little farther, our wonder will be greatly increased. The matter which, when converted into flame, is an inch in diameter, is not, when of the consistence of cotton and tallow, of the dimensions of the 20th part of an inch; and therefore, on the common hypothesis, the 20th part of an inch of tallow may be so rarefied as to fill a space of 113.0976 cubic miles! a rarefaction which to us appears altogether incredible. We have indeed heard much of the divisibility of matter *ad infinitum*, and think we understand what are usually called *demonstrations* of the truth of that proposition; but these demonstrations prove not the actual divisibility of real solid substances, but only that on trial we shall find no end of the ideal process of dividing and subdividing imaginary extension.

On the whole, therefore, we are much more inclined to believe that the matter of light is an extremely subtile fluid, diffused through the corporeal universe, and only excited to agency by the sun and other fiery bodies, than that it consists of streams continually issuing from the substance of these bodies. It is indeed an opinion pretty generally received, and certainly not improbable in itself, that light and electricity are one and the same substance (see ELECTRICITY-*Index*); but we know that the electrical fluid, though pervading the whole of corporeal nature, and, as experiments show, capable of acting with great violence, yet lies dormant and unperceived till its agency be excited by some foreign cause. Just so it may be with the matter of light. That substance may be "diffused from one end of the creation * to the other. It may traverse the whole universe, form a communication between the most remote spheres, penetrate into the inmost recesses of the earth, and only wait to be put in a proper motion to communicate visible sensations to the eye. Light is to the organ of sight what the air is to the organ of hearing. Air is the medium which, vibrating on the ear, causes the sensation of sound; but it equally exists round us at all times, though there be no sonorous body to put it in motion. In like manner, light may be equally extended at all times, by night as well as by day, from the most distant fixed stars to this earth, though it then only strikes our eyes so as to excite visible sensations when impelled by the sun or some other mass of

* *Nature displayed.*

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of fire." Nor let any one imagine that this hypothesis interferes with any of the known laws of optics; for if the rays of light be impelled in straight lines, and in the same direction in which they are supposed to be emitted, the phenomena of vision must necessarily be the same.

72 Moses a sound philosopher.

Moses therefore was probably a more accurate philosopher than he is sometimes supposed to be. The element of light was doubtless created, as he informs us, on the first day; but whether it was then put in that state in which it is the medium of vision, we cannot know, and we need not inquire, since there was neither man nor inferior animal with organs fitted to receive its impressions. For the first three days it may have been used only as a powerful instrument to reduce into order the jarring chaos. Or if it was from the beginning capable of communicating visible sensations, and dividing the day from the night, its agency must have been immediately excited by the Divine power till the fourth day, when the sun was formed, and endowed with proper qualities for instrumentally discharging that office. This was indeed miraculous, as being contrary to the present laws of nature: but the whole creation was miraculous; and we surely need not hesitate to admit a less miracle where we are under the necessity of admitting a greater. The power which called light and all other things into existence, could give them their proper motions by ten thousand different means; and to attempt to solve the difficulties of creation by philosophic theories respecting the laws of nature, is to trifle with the common sense of mankind: it is to consider as subservient to a law that very power by whose continued exertion the law is established.

Having thus proved that the universe derives its being, as well as the form and adjustment of its several parts, from the one supreme and self-existent God, let us here pause, and reflect on the sublime conceptions which such astonishing works are fitted to give us of the divine perfections.

73 Infinite power of the Creator.

And, in the first place, how strongly do the works of creation impress on our minds a conviction of the infinite power of their Author? He spoke, and the universe started into being; he commanded, and it stood fast. How mighty is the arm which "stretched out the heavens and laid the foundations of the earth; which removeth the mountains and they know it not; which overturneth them in his anger; which shaketh the earth out of her place, and the pillars thereof tremble! How powerful the word which commandeth the sun, and it riseth not; and which sealeth up the stars;" which sustaineth numberless worlds of amazing bulk suspended in the regions of empty space, and directs their various and inconceivably rapid motions with the utmost regularity! "Lift up your eyes on high, and behold, who hath created all these things? By the word of the Lord were the heavens made, and all the host of them by the breath of his mouth. Hell is naked before him, and destruction hath no covering. He stretcheth out the North over the empty place, and hangeth the earth upon nothing. He has measured the waters in the hollow of his hand, and meted out the heavens with a span; and comprehended the dust of the earth in a measure; and weighed the mountains in scales, and the hills in a balance. Behold! the nations are as a drop of the bucket, and are counted as the small dust of the balance; behold, he taketh up the isles as a very little thing. All nations before him are as nothing, and they are counted to him less than nothing, and vanity. To whom then will ye liken God, or what likeness will ye compare unto him * ?"

* Ps. xxxiii. 6, 9; Job ix. 4. &c. xxvi. 6; Isa. xi. 12.

74 His wisdom.

As the works of creation are the effects of God's power, they likewise in the most eminent manner display his wisdom. This was so apparent to Cicero, even from the partial knowledge in astronomy which his time afforded, that he declared † those who could assert the contrary void of all understanding. But if that great master of reason had been acquainted with the modern discoveries in astronomy, which exhibit numberless worlds scattered through space, and each of immense magnitude; had he known that the sun is placed in the centre of our system, and that to diversify the seasons the planets move round him with exquisite regularity; could he have conceived that the distinction between light and darkness is produced by the diurnal rotation of the earth on its own axis, instead of that disproportionate whirling of the whole heavens which the ancient astronomers were forced to suppose; had he known of the wonderful motions of the comets, and considered how such eccentric bodies have been preserved from falling upon some of the planets in the same system, and the several systems from falling upon each other; had he taken into the account that there are yet greater things than these, and "that we have seen but a few of God's works;"— that virtuous Pagan would have been ready to exclaim in the words of the Psalmist, "O Lord, how manifold are thy works! In wisdom hast thou made them all; the earth is full of thy riches."

† *De Nat. Deorum*, lib. ii.

75 and goodness.

That creation is the offspring of unmixed goodness, has been already shown with sufficient evidence (see METAPHYSICS, N° 312. and N° 29. of this article); and from the vast number of creatures on our earth endowed with life and sense, and a capability of happiness, and the infinitely greater number which probably inhabit the planets of this and other systems, we may infer that the goodness of God is as boundless as his power, and that "as is his majesty, so is his mercy." Out of his own fulness hath he brought into being numberless worlds, replenished with myriads of myriads of creatures, furnished with various powers and organs, capacities and instincts; and out of his own fulness he continually and plentifully supplies them all with every thing necessary to make their existence comfortable. "The eyes of all wait upon him, and he giveth them their meat in due season. He openeth his hand and satisfies the desires of every living thing; he loveth righteousness and judgment; the earth is full of the goodness of the Lord. He watereth the ridges thereof abundantly; he settleth the furrows thereof; he maketh it soft with showers, and blesseth the springing thereof. He crowneth the year with his goodness; and his paths drop fatness. They drop upon the pastures of the wilderness; and the little hills rejoice on every side. The pastures are clothed with flocks; the valleys also are covered with corn; they shout with joy, they also sing ‡." Survey the whole of what may be seen on and about this terraqueous globe, and say, if our Maker hath a sparing hand. Surely the Author of so much happiness must be essential goodness; and we must conclude with St John, that "God is love."

‡ Ps. cxiv. 15, 16. xxiii. 5. lv. 10. &c.

These attributes of power, wisdom, and goodness, so conspicuously

God and his Attributes.

conspicuously displayed in the works of creation, belong in the same supreme degree to each person in the blessed Trinity; for Moses declares that the heaven and the earth were created, not by *one* person, but by the *Elohim*. The λογος indeed, or second person, appears to have been the *immediate* Creator; for St John assures us *, that "all things were made by him, and that without him was not any thing made that was made." Some Arian writers of great learning (and we believe the late Dr Price was of the number) have asserted, that a being who was created himself may be endowed by the Omnipotent God with the power of creating other beings; and as they hold the λογος or *word*, to be a creature, they contend that he was employed by the Supreme Deity to create, not the whole universe, but only this earth, or at the utmost the solar system. "The old argument (says one of them), that no being inferior to the great Omnipotent can create a world, is so childish as to deserve no answer. Why may not God communicate the power of making worlds to any being whom he may choose to honour with so glorious a prerogative? I have no doubt but such a power may be communicated to many good men during the progress of their existence; and to say that it may *not*, is not only to limit the power of God, but to contradict acknowledged analogies."

76 The second person in the Trinity the immediate Creator.

* Ch. i. 3.

77 Creation peculiar to God.

We are far from being inclined to limit the power of God. He can certainly do whatever involves not a direct contradiction; and therefore, though we know nothing *analogous* to the power of *creating worlds*, yet as we perceive not any contradiction implied in the notion of that power being communicated, we shall admit that such a communication may be *possible*, though we think it in the highest degree *improbable*. But surely no man will contend that the *whole universe* was brought into existence by *any creature;* because that creature himself, however highly exalted, is necessarily comprehended in the notion of the universe. Now St Paul expressly affirms †, that, by the second person in the blessed Trinity, "were ALL *things* created that are in heaven, and that are in earth, *visible* and *invisible*, whether they be THRONES, or DOMINIONS, or PRINCIPALITIES, or POWERS; all things were created by him and for him; and he is before all things, and by him all things consist." Indeed the Hebrew Scriptures in more places than one ‡ expressly declare that this earth, and of course the whole solar system, was *formed*, as well as *created*, not by an inferior being, but by the *true* God, even *Jehovah* alone; and in the New Testament §, the Gentiles are said to be without excuse for not glorifying him as God, "because his eternal power and Godhead are clearly seen from the creation of the world." But if it were natural to suppose that the power of creating worlds has been, or ever will be, communicated to beings inferior to the great Omnipotent, this reasoning of the apostle's would be founded on false principles, and the sentence which he passed on the Heathen would be contrary to justice.

† Colos. iv. 17.

‡ Isa. xl. 12. xliv. 24. Jerem. x. 10—13.

§ Rom. i. 18—22.

But though it be thus evident that the λογος was the immediate Creator of the universe, we are not to suppose that it was without the concurrence of the other two persons. The Father, who may be said to be the fountain of the Divinity itself, was certainly concerned in the creation of the world, and is therefore in the apostle's creed denominated the "Father Almighty Maker of heaven and earth;" and that the Holy Ghost or third person is likewise a Creator, we have the express testimony of two inspired writers: "By the word of the Lord (says the Psalmist) were the heavens made, and all the host of them by the breath (Hebrew, SPIRIT) of his mouth." And Job declares, that the "SPIRIT of God made him, and that the breath of the Almighty gave him life." Indeed these three divine persons are so intimately united, that what is done by one must be done by all, as they have but one and the same will. This is the reason assigned by Origen * for our paying divine worship to each; *θρησκευόμεν ουν τον πατερα της αληθειας και τον υιον την αληθειαν οντα δυο τη υποστασει πραγματα, εν δε τη ομονοια, και τη συμφωνια και τη ταυτοτητι της βουλησεως*, "we worship the Father of truth, and the Son the truth itself, being two things as to hypostasis, but one in agreement, consent, and sameness of will." Nor is their union a mere agreement in will only; it is a physical or essential union: so that what is done by one must necessarily be done by the others also, according to that of our Saviour, "I am in the Father and the Father in me: The Father who dwelleth in me, he doth the works."

* *Contr. Cels.* p. 386.

SECT. II. *Of the Original State of Man, and the first Covenant of Eternal Life which God vouchsafed to make with him.*

78 Peculiarity of the expression in which God is said to make man.

In the Mosaic account of the creation, every attentive reader must be struck with the manner in which the supreme Being is represented as making man: "And God said, let us make man in our image, after our likeness; and let *them* have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth. So God created man in his own image; in the image of God created he him; male and female created he THEM. And God blessed them; and God said unto them, be fruitful, and multiply, and replenish the earth, and subdue it; and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth. And God said, behold, I have given you every herb bearing seed, which is upon the face of all the earth; and every tree, in the which is the fruit of a tree yielding seed: to you it shall be for meat. And God saw every thing that he had made, and, behold, it was very good. And the evening and the morning were the sixth day. Thus the heavens and the earth were finished, and all the host of them. And on the seventh day God ended his work which he had made; and he rested on the seventh day from all his works which he had made. And God blessed the seventh day and sanctified it: because that in it he had rested from all his work which God created and made ‡."

‡ Gen. i. 26, &c. ii. 1, 2, 3.

This is a very remarkable passage, and contains much important information. It indicates a plurality of persons in the Godhead, describes the nature of man as he came at first from the hands of his Creator, and furnishes data from which we may infer what were the duties required of him in that primeval state, and what were the rewards to which obedience would entitle him.

79 In his own image.

Of the plurality of Divine persons, and their essential union, we have treated in the preceding section, and proceed now to inquire into the specific nature of the first man. This must be implied in the *image of God*, in

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in which he is said to have been created; for it is by that phrase alone that he is characterized, and his pre-eminence marked over the other animals. Now this image or likeness must have been found either in his body alone, his soul alone, or in both united. That it could not be in his body alone, is obvious; for the infinite and omnipotent God is allowed by all men to be without body, parts, or passions, and therefore to be such as nothing corporeal can possibly resemble.

80 Different opinions respecting the image of God.

If this likeness is to be found in the human soul, it comes to be a question in what faculty or power of the soul it consists. Some have contended, that man is the only creature on this earth who is animated by a principle essentially different from matter; and hence they have inferred, that he is said to have been formed in the Divine image, on account of the immateriality of that vital principle which was infused into his body when the "Lord God breathed into his nostrils the breath of life, and man became a living soul †." That this account of the animation of the body of man indicates a superiority of the human soul to the vital principle of all other animals, cannot, we think, be questioned; but it does not therefore follow, that the human soul is the only immaterial principle of life which animates any terrestrial creature. It has been shown elsewhere (see METAPHYSICS, N° 235.), that the power of sensation, attended with individual consciousness, as it appears to be in all the higher species of animals, cannot result from any organical structure, or be the quality of a compound extended being. The vital principle in such animals therefore must be immaterial as well as the human soul; but as the word *immaterial* denotes only a negative notion, the souls of men and brutes, though both immaterial, may yet be substances essentially different. This being the case, it is plain that the Divine image in which man was formed, and by which he is distinguished from the brute creation, cannot consist in the mere circumstance of his mind being a substance different from matter, but in some positive quality which distinguishes him from every other creature on this globe.

† Gen. ii. 7.

81 Calvinistic opinions.

About this characteristic quality various opinions have been formed. Some have supposed ‡ "that the image of God in Adam appeared in that rectitude, righteousness, and holiness, in which he was made; for God made man upright (Eccles. vii. 2.), a holy and righteous creature; which holiness and righteousness were in their kind perfect; his understanding was free from all error and mistakes; his will biassed to that which is good; his affections flowed in a right channel towards their proper objects; there were no sinful motions and evil thoughts in his heart, nor any propensity or inclination to that which is evil; and the whole of his conduct and behaviour was according to the will of God. And this righteousness (say they) was *natural*, and not personal and acquired. It was not obtained by the exercise of his free-will, but was created with him, and belonged to his mind, as a natural faculty or instinct." They therefore call it *original righteousness*, and suppose that it was lost in the fall.

‡ *Gill's Body of Divinity*, b. iii. ch. 3.

82 Objected to.

To this doctrine may objections have been made. It has been said that righteousness consisting in right actions proceeding from proper principles, could not be created with Adam and make a part of his nature; because nothing which is produced in a man without his knowledge and consent can be in him either virtue or vice. Adam, it is added, was unquestionably placed in a state of trial, which proves that he had righteous habits to *acquire*; whereas the doctrine under consideration, affirming his original righteousness to have been perfect, and therefore incapable of improvement, is inconsistent with a state of trial. That his understanding was free from all errors and mistakes, has been thought a blasphemous position, as it attributes to man one of the incommunicable perfections of the Deity. It is likewise believed to be contrary to fact; for either his understanding was bewildered in error, or his affections flowed towards an improper object, when he suffered himself at the persuasion of his wife to transgress the express law of his Creator. The objector expresses his wonder at its having ever been supposed that the *whole* of Adam's conduct and behaviour was according to the will of God, when it is so notorious that he yielded to the first temptation with which, as far as we know, he was assailed in paradise.

Convinced by these and other arguments, that the image of God in which man was created could not consist in original righteousness, or in exemption from all possibility of error, many learned men, and Bishop Bull § among others, have supposed, that by the image of God is to be understood certain gifts and powers supernaturally infused by the Holy Spirit into the minds of our first parents, to guide them in the ways of piety and virtue. This opinion they rest chiefly upon the authority of Tatian, Irenæus, Tertullian, Cyprian, Athanasius, and other fathers of the primitive church; but they think, at the same time, that it is countenanced by several passages in the New Testament. Thus when St Paul says ||, "and so it is written, The first man Adam was made a living soul, the last Adam was made a quickening Spirit;" they understand the whole passage as relating to the creation of man, and not as drawing a comparison between Adam and Christ, to show the great superiority of the latter over the former. In support of this interpretation they observe, that the apostle immediately adds, "howbeit, that was not first which is spiritual, but that which is natural, and afterwards that which is spiritual;" an addition which they think was altogether needless, if by the quickening Spirit he had referred to the incarnation of Christ, which had happened in the very age in which he was writing. They are therefore of opinion, that the body of Adam, after being formed of the dust of the ground, was first animated by a vital principle endowed with the faculties of reason and sensation, which entitled the whole man to the appellation of a living soul. After this they suppose certain graces of the Holy Spirit to have been infused into him, by which he was made a quickening spirit, or formed in the image of God; and that it was in consequence of this succession of powers communicated to the same person, that the apostle said, "Howbeit, that was not first which is spiritual, but that which is natural."

§ See his *English Works*, vol. iii.

83 Opinion of Bishop Bull and some of the ancient fathers.

|| 1 Cor. xv. 45, 46.

We need hardly observe, that with respect to a question of this kind the authority of *Tatian* and the other fathers quoted is nothing. Those men had no better means of discovering the true sense of the scriptures of the Old Testament than we have; and their ignorance of the language in which these scriptures are written, added to some metaphysical notions respecting the soul, which

which too many of them had derived from the school of Plato, rendered them very ill qualified to interpret the writings of Moses. Were authority to be admitted, we should consider that of Bishop Bull and his modern followers as of greater weight than the authority of all the ancients to whom they appeal. But authority cannot be admitted; and the reasoning of this learned and excellent man from the text of St Paul is surely very inconclusive. It makes two persons of Adam; a first,

84 ill-founded.

when he was a natural man composed of a body and a reasonable soul; a second, when he was endowed with the gifts of the Holy Spirit, and by them formed in the image of God! In the verse following too, the apostle expressly calls the second man, of whom he had been speaking, "the Lord from heaven;" but this appellation we apprehend to be too high for Adam in the state of greatest perfection in which he ever existed. That our first parents were endowed with the gifts of the Holy Ghost, we are strongly inclined to believe for reasons which shall be given by and by; but as these gifts were adventitious to their nature, they could not be that image in which God *made* man.

85 Other opinions.

Since man was *made* in the image of God, that phrase, whatever be its precise import, must denote something *peculiar* and at the same time essential to human nature; but the only two qualities at once natural and peculiar to man are his shape and his reason. As none but an anthropomorphite will say that it was Adam's shape which reflected this image of his Creator, it has been concluded that it was the faculty of reason which made the resemblance. To give strength to this argument it is observed †, that when God says, "let us make man in our image," he immediately adds, "and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth;" but as many of the cattle have much greater bodily strength than man, this dominion could not be maintained but by the faculty of reason bestowed upon him and withheld from them.

† *Warburton's Divine Leg.* book ix.

If the image of God was impressed only on the mind of man, this reason seems to be conclusive; but it has been well observed ‡ that it was the whole man, and not the *soul alone*, or the *body* alone, that is said to have been formed in the divine image; even as the whole man, soul and body, is the seat of the new and spiritual image of God in regeneration and sanctification. "The very God of peace (says the apostle) sanctify you wholly; and may your whole *spirit*, *soul*, and *body*, be preserved blameless to the coming of our Lord Jesus Christ." It is worthy of notice, too, that the reason assigned for the prohibition of murder to Noah and his sons after the deluge, is, that man was made in the image of God. "Whoso sheddeth man's blood, by man shall his blood be shed; for in the image of God made he man." These texts seem to indicate, that whatever be meant by the image of God, it was stamped equally on the soul and on the body. In vain is it said that man cannot resemble God in shape. This is true, but it is little to the purpose; for man does not resemble God in his reasoning faculty more than in his form. It would be idolatry to suppose the supreme majesty of heaven and earth to have a body or a shape; and it would be little short of idolatry to imagine that he is obliged to compare ideas and notions together; to advance from particular truths to general propositions; and to acquire acknowledge, as we do, by the tedious processes of inductive and syllogistic reasoning. There can therefore be no direct image of God either in the soul or in the body of man; and the phrase really seems

‡ *Gill's Body of Divinity*, book iii. chap. 3.

86 True import of the phrase.

to import nothing more than those powers or qualities by which man was fitted to exercise dominion over the inferior creation; as if it had been said, "Let us make man in our image, after our likeness, that *they may have* dominion, &c." But the erect form of man contributes in some degree, as well as his rational powers, to enable him to maintain his authority over the brute creation; for it has been observed by travellers, that the fiercest beast of prey, unless ready to perish by hunger, shrinks back from a steady look of the human face divine.

By some *, however, who have admitted the probability of this interpretation, another has been devised for its being said that man was formed in the image of God. All the members of Christ's body, say they, were written and delineated in the book of God's purposes and decrees, and had an ideal existence from eternity in the divine mind; and therefore the body of Adam might be said to be formed after the image of God, because it was made according to that idea. But to this reasoning objections may be urged, which we know not how to answer. All things that ever were or ever shall be, the bodies of us who live at present as well as the bodies of those who lived 5000 years ago, have from eternity had an ideal existence in the Divine mind; nor in this sense can one be said to be prior to another. It could not therefore be after the idea of the identical body of Christ that the body of Adam was formed; for in the Divine mind ideas of both bodies were present together from eternity, and each body was formed after the ideal archetype of itself. It may be added likewise, that the body of Christ was not God, nor the idea of that body the idea of God. Adam therefore could not with propriety be said to have been formed in the image of God, if by that phrase nothing more were intended than the resemblance between his body and the body of Christ. These objections to this interpretation appear to us unanswerable; but we mean not to dictate to our readers. Every man will adopt that opinion which he thinks supported by the best arguments; but it is obvious, that whatever more may be meant by the image of God in which man was made, the phrase undoubtedly comprehends all those powers and qualities by which he is enabled to maintain his authority over the inferior creation. Among these the faculty of reason is confessedly the most important; for it is by it that man is capable of being made acquainted with the Author of his being, the relation which subsists between them, and the duties implied in that relation from the creature to the Creator.

* *Gill*, &c.

87 Religious instruction communicated to Adam.

That the first man, however, was not left to discover these things by the mere efforts of his own unassisted reason, we have endeavoured to show in another place; (see Religion, N° 5—10.); and the conclusion to which we were there led, is confirmed by the portion of revelation before us. The inspired historian says, that "God blessed the seventh day and *sanctified* it, because that in it he had rested from all his works, which he created and made;" but Adam could not have understood what was meant by the *sanctification* of a particular day, or of any thing else, unless he had previously received

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received some religious instruction. There cannot therefore be a doubt, but that as soon as man was made, his Creator communicated to him the truths of what is called natural religion, which we have endeavoured to explain and establish in Part I. of this article; and to these were added the precept to keep holy the Sabbath-day, and set it apart for the purposes of contemplation and worship.

88 Institution of the Sabbath.

This was a very wise institution, as all the divine institutions must be. "The great end for which we are brought into life, is to attain the knowledge and be confirmed in the love of God. This includes obedience to his will in thought, word, and deed, or that course of conduct which can alone make us happy here, and fit us for everlasting glory hereafter. But of these things we cannot retain a proper sense without close and repeated application of thought; and the unavoidable cares and concerns of the present life occupying much of our attention, it is, in the nature of things, necessary that some certain portion of time should be appropriated to the purposes of religious instruction and the public adoration of our Creator, in whom we all live, and move, and have our being." Hence a very learned divine † has inferred, that though the particular time is a matter of positive appointment, the observation of a sabbath in general is a duty of natural religion, as having its foundation in the reason of things. See SABBATH.

† *Dr Taylor of Norwich.*

89 Duties of man in his original state,

Man therefore in his *natural* and original state was a rational and religious being, bound to do "justice, to love mercy, to walk humbly with his God, and to keep holy the Sabbath-day." These seem to be all the duties which in that state were required of him; for as soon as he was introduced into the terrestrial paradise and admitted into covenant with his Maker, he was placed in a *supernatural* state, when other duties were of course enjoined.

That our first parents were both made on the sixth day, Moses expressly affirms when he says ‡, that "God created them male and female, and blessed them, and called *their* name *Adam* (K), in the day when they were created:" but that they were introduced into the garden of Eden on that day, is an opinion which, however generally it may be received, seems not to be reconcileable with the plain narrative of the sacred penman. After telling us that on the sixth day God finished all his works, which he saw to be very good, and rested on the seventh day, he briefly recapitulates the history of the generations of the heavens and of the earth, gives us a more particular account of the formation of the first man, informing us that the "Lord God formed him out of the dust of the ground, and breathed into his nostrils the breath of life, when man became a living soul;" and then proceeds to say ‖, that the "Lord God planted a garden eastward in Eden, where he put the man whom he HAD *formed*." From this short history of the first pair it appears beyond dispute evident, that neither the man nor the woman was formed *in* the garden; and that from their creation some time elapsed before the garden was prepared for their reception, is likewise evident from a comparison of Gen. i. 29. with Gen. ii. 16, 17. In the first of these passages God gives to man, immediately after his creation, "every herb bearing seed which was upon the face of all the earth, and *every tree*, without exception, in which was the fruit of a tree bearing seed: to him he said it should be for meat." In the second, "he commanded the man saying, of every tree of the garden thou mayest freely eat; but of the tree of knowledge of good and evil, thou shalt not eat of it; for in the day thou eatest thereof thou shalt surely die." When the first grant of food was given, Adam and his wife must have been where no tree of knowledge grew, and they must have been intended to live at least so long in that state as that they should have occasion for food, otherwise the formal grant of it would have been not only superfluous, but apt to mislead them with respect to the subsequent restriction.

‡ Gen. i. 27. v. 2.

‖ Gen. ii. 7, 8, and 15.

90 before he was placed in the garden of Eden,

In this original state man was under the discipline of what we have called *natural religion*, entitled to happiness while he should perform the duties required of him, and liable to punishment when he should neglect those duties, or transgress the law of his nature as a rational and moral agent. This being the case, it is a matter of some importance, to ascertain, if we can, what the rewards and punishments are which natural religion holds out to her votaries.

That under every dispensation of religion the pious and virtuous man shall enjoy more happiness than misery; and that the incorrigibly wicked shall have a greater portion of misery than happiness, are truths which cannot be controverted by any one who admits, that the Almighty governor of the universe is a Being of wisdom, goodness, and justice. But respecting the rewards of virtue and the punishment of vice, more than these general truths seems not to be taught by natural religion. Many divines, however, of great learning and worth, have thought otherwise, and have contended, that from the nature of things the rewards bestowed by an infinite God upon piety and virtue must be eternal like their author. These men indeed appear willing enough to allow that the punishments with which natural religion is armed against vice must be only of a temporary duration, because reason, say they, is ready to revolt at the thought of *everlasting* punishment.

91 did not when performed, entitle him to eternal life.

This opinion, which confounds natural with revealed religion, giving to the former an important truth which belongs exclusively to the latter, has been so ably confuted by a learned writer, that we shall submit his arguments to our readers in preference to any thing which we can give ourselves.

"If reason doth, on the one hand, seem to revolt at *everlasting punishment*, we must confess that FANCY, on the other, (even when full plumed by *vanity*), hath scarcely force enough to rise to the idea of *infinite rewards*. How the heart of man came to consider this as no more than an adequate retribution for his right conduct during the short trial of his virtue here, would be

(K) The woman was some time afterwards distinguished by the name of Eve, חוה, because she was to be the mother of all living, and particularly of that blessed seed which was to bruise the head of the serpent. See *Parkhurst's Lexicon* on the word.

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be hard to tell, did we not know what monsters PRIDE begot of old upon *Pagan philosophy*; and how much greater still these latter ages have disclosed, *by the long* incubation of *school-divinity* upon *folly*. What hath been urged from natural reason, in support of this extravagant presumption, is so very slender, that it recoils as you enforce it. First, you say, "that the soul, the subject of these eternal rewards, being *immaterial*, and so therefore unaffected by the causes which bring material things to an end, is, by its nature, fitted for eternal rewards.—This is an argument *ad ignorantiam*, and holds no farther.—Because an *immaterial* being is not subject to that mode of dissolution which affects *material* substances, you conclude it to be eternal. This is going too fast. There may be, and probably are, many natural causes (unknown indeed to us), whereby immaterial beings come to an end. But if the nature of things cannot, yet God certainly can, put a final period to such a being when it hath served the purpose of its creation. Doth ANNIHILATION impeach that wisdom and goodness which was displayed when God brought it *out of nothing*? Other immaterial beings there are, viz. the souls of brutes, which have the same natural security with man for their existence, of whose *eternity* we never dream. But pride, as the poet observes, *calls God unjust*,

92 Arguments to prove that they did inconclusive.

> If man alone engross not heaven's high care;
> Alone made *perfect* here, IMMORTAL there.

However, let us (for argument's sake) allow the human soul to be unperishable by nature, and secured in its existence by the unchangeable will of God, and see what will follow from thence—An *infinite* reward for virtue during one moment of its existence, because reason discovers that, by the law of nature, *some* reward is due? By no means. When God hath amply repaid us for the performance of our duty, will he be at a loss how to dispose of us for the long remainder of *eternity*? May he not find new and endless employment for reasonable creatures, to which, when properly discharged, new rewards and in endless succession will be assigned? Modest reason seems to dictate this to the followers of the *law of nature*. The flattering expedient of ETERNAL REWARDS for virtue here was invented in the simplicity of early speculation, after it had fairly brought men to conclude that the soul is immaterial.

"Another argument urged for the eternity of the rewards held out by natural religion to the practice of piety and virtue is partly physical and partly moral. The merit of service (say the admirers of that religion) increases in proportion to the excellence of that Being to whom our service is directed and becomes acceptable. An infinite being, therefore, can dispense no rewards but what are infinite. And thus the virtuous man becomes entitled to immortality.

"The misfortune is, that this reasoning holds equally on the side of the unmerciful doctors, as they are called, who doom the wicked to EVERLASTING PUNISHMENT. Indeed were this the only discredit under which it labours, the merciless doctors would hold themselves little concerned. But the truth is, that the argument from *infinity* proves just nothing. To make it of any force, both the parties should be *infinite*. This inferior emanation of God's *image*, MAN, should either be supremely good or supremely bad, a kind of deity or a kind of devil. But these reasoners, in their attention to the *divinity*, overlook the *humanity*, which makes the decrease keep pace with the accumulation, till the rule of logic, that the *conclusion follows the weaker* part, comes in to end the dispute *."

* Warburton's Divine Legation, book ix.

These arguments seem to prove unanswerably that immortality is not essential to any part of the compound being man, and that it cannot be claimed as a reward due to his virtue. It is not indeed essential to any created being, for what has not existence of itself, cannot of itself have perpetuity of existence (see METAPHYSICS, N° 272, &c.); and as neither man nor angel can be profitable to God, they cannot claim from him any thing as a debt. Both, indeed, as moral agents, have duties prescribed them; and while they faithfully perform these duties, they have all the security which can arise from the perfect benevolence of him who brought them into existence, that they shall enjoy a sufficient portion of happiness to make that existence preferable to non-existence; but reason and philosophy furnish no data from which it can be inferred that they shall exist for ever. Man is composed in part of perishable materials. However perfect Adam may be thought to have been when he came first from the hands of his Creator, his body, as formed of the dust of the ground, must have been naturally liable to decay and dissolution. His soul, indeed, was of a more durable substance; but as it was formed to animate his body, and had no prior conscious existence, it is not easy to conceive what should have led him, under an equal providence, where rewards and punishments were exactly distributed, to suppose that one part of him should survive the other. In his natural and original state, before the covenant made with him in paradise, he was unquestionably a mortal creature. How long he continued in that state, it seems not possible to form a plausible conjecture. Bishop Warburton supposes him to have lived several years under no other dispensation than that of natural religion; during which he was as liable to death as his fallen posterity are at present.

93 Adam before his introduction into paradise liable to death.

"We must needs conclude (says this learned writer*), that God having tried Adam in *the state of nature*, and approved of the good use he made of his free-will under the direction of that light, advanced him to a superior station in *Paradise*. How long, before this remove, man had continued subject to *natural religion* alone, we can only guess: but of this we may be assured, that it was some considerable time before the garden of Eden could naturally be made fit for his reception. Since Moses, when he had concluded his history of the creation, and of God's *rest* on, and *sanctification* of, the seventh day, proceeds to speak of the condition of this new world in the following terms: "*And God made every plant of the field before it was in the earth, and every herb of the field before it grew; for the Lord God had not caused it to rain upon the earth* ‡." Which seems plainly to intimate, that when the seeds of vegetables had been created on the third day, they were left to nature, in its ordinary operations, to mature by sun and showers. So that when in course of time Paradise was become capable of accommodating its inhabitants, they were transplanted thither."

* Divine Legation, book ix. chap. i.

94 How long he continued in that state.

‡ Gen. ii. 4, 5.

This reasoning is not without a portion of that ingenuity which was apparent in every thing that fell from the pen of Warburton; but it was completely confut-ed

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ed almost as soon as it was given to the public, and shown to be deduced from premises which could be employed against the author's system. If only the *seeds* of vegetables were created on the third day, and then left to nature, in its ordinary operations, to mature by sun and showers, the first pair must have perished before a single vegetable could be fit to furnish them with food; and we may suppose that it was to prevent this disaster that the garden of Eden was miraculously stored at once with full grown trees and fruit in perfect maturity, whilst the rest of the earth was left under the ordinary laws of vegetation. There is, however, no evidence that they were only the *seeds* of vegetables that God created. On the contrary, Moses says expressly *, that God made the earth on the third day bring forth the herb *yielding* seed after his kind, and the tree *yielding fruit* whose *seed* was in itself after his kind;" and when he recapitulates the history of the creation, he says, that God made, not every seed, but every *plant* of the field *before* it was in the earth, and every *herb* of the field *before* it grew. From the process of vegetation, therefore, nothing can be inferred with respect to the time of Adam's introduction into paradise, or to ascertain the duration of his original state of nature. If angels were created during the six days of which the Hebrew lawgiver writes the history, an hypothesis very generally received (see ANGEL), though in the opinion of the present writer not very probable, there can be no doubt but our first parents lived a considerable time under the law of nature before they were raised to a superior station in the garden of Eden; for it seems very evident that the period of their continuance *in* that station was not long. Of this, however, nothing can be said with certainty. They may have lived for years, or only a few days in their original state; but it is very necessary to distinguish between that state in which they were under no other dispensation than what is commonly called *natural religion*, entitled, upon their obedience, to the indefinite rewards of piety and virtue, and their state in Paradise when they were put under a new law, and by the free grace of God promised, if they should be obedient, a supernatural and eternal reward. Into that state we must now attend them, and ascertain, if we can, the precise terms of the first covenant.

* Gen. i. 12.

95 impossible to be known.

Moses, who in this investigation is our only guide, tells us, that the Lord God, after he had formed the first pair, "planted a garden eastward in Eden, and took the man and put him in the garden to dress it and to keep it. And the Lord God (continues he) commanded the man, saying, Of every tree of the garden thou mayest freely eat; but of the tree of the knowledge of good and evil thou shalt not eat of it; for in the day that thou eatest thereof, thou shalt surely die †." Here is no mention made of the laws of piety and moral virtue resulting from the relations in which the various individuals of the human race stand to each other, and in which all his creatures stand to God their Almighty and beneficent Creator. With these laws Adam was already well acquainted; and he must have been sensible, that as they were founded in his nature, no subsequent law could dispense with their obligation. They have been equally binding on all men in every state and under every dispensation; and they will continue to be so as long as the general practice of justice, mercy, and piety, shall contribute to the sum of human happiness. The new law peculiar to his paradisaical state was the command not to eat of the fruit of the tree of the knowledge of good and evil. This was a positive precept, not founded in the nature of man, but very proper to be the test of his obedience to the will of his Creator. The laws of piety and virtue are sanctioned by nature, or by that general system of rules according to which God governs the physical and moral worlds, and by which he has secured, in some state or other, happiness to the pious and virtuous man, and misery to such as shall prove incorrigibly wicked. The law respecting the forbidden fruit was sanctioned by the penalty of *death* denounced against disobedience; and by the subjects of that law the nature of this penalty must have been perfectly understood: but Christian divines, as we shall afterwards see, have differed widely in opinion respecting the full import of the Hebrew words which our translators have rendered by the phrase *thou shalt surely die*. All, however, agree that they threatened death, in the common acceptation of the word, or the separation of the soul and body, as one part of the punishment to be incurred by eating the forbidden fruit; and hence we must infer, that had the forbidden fruit not been eaten, our first parents would never have died, because the penalty of death was denounced against no other transgression. What therefore is said respecting the fruit of the tree of knowledge, implies not only a law but also a covenant (L), promising to man, upon the observance of one positive precept, immortality or eternal life; which is not essential to the nature of any created being, and cannot be claimed as the merited reward of the greatest virtue or the most fervent piety.

† Gen. ii. 8, 15, 16, 17.

96 The covenant of eternal life made with Adam in paradise.

This obvious truth will enable us to dispose of the objections which have been sometimes brought by freethinking divines against the wisdom and justice of punishing so severely as by death the breach of a mere positive precept; which, considered in itself, appears to be a precept of very little importance. We have only to reply, that as an exemption from death is not due either

(L) It does not appear that any transaction between God and mankind in general was denominated by a word equivalent to the English word *covenant* till the end of the fourth century, when such phraseology was introduced into the church by the celebrated Augustine, bishop of Hippo. That the phraseology is strictly proper, no man can suppose who reflects on the infinite distance between the contracting parties, and absolute dominion of the one over the other. To be capable of entering into a *covenant*, in the proper sense of the word, both parties must have a right either to agree to the terms proposed or to reject them; but surely Adam had no right to bargain with his Maker, or to refuse the gift of immortality on the terms on which it was offered to him. The word *dispensation* would more accurately denote what is here meant by the word *covenant*; but as this last is in general use, we have retained it as sufficient, when thus explained, to distinguish what man received from God upon certain positive conditions, from what he had a claim to by the constitution of his nature.

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either to the nature or to the virtue of man, it was wise and just to make it depend on the observance of a positive precept, to impress on the minds of our first parents a constant conviction, that they were to be preserved immortal, not in the ordinary course of divine providence, but by the special grace and favour of God. The same consideration will show us the folly of those men who are for turning all that is said of the trees of knowledge and of life into figure and allegory. But the other trees which Adam and Eve were permitted to eat were certainly real trees, or they must have perished for want of food. And what rules of interpretation will authorise us to interpret *eating* and *trees* literally in one part of the sentence and figuratively in the other? A garden in a delightful climate is the very habitation, and the fruits produced in that garden the very food, which we should naturally suppose to have been prepared for the progenitors of the human race; and though in the garden actually fitted up for this purpose two trees were remarkably distinguished from the rest, perhaps in situation and appearance as well as in use, the distinction was calculated to serve the best of purposes. The one called the *tree of life*, of which, while they continued innocent, they were permitted to eat, served as a sacramental pledge or assurance on the part of God, that as long as they could observe the terms of the covenant their life should be preserved; the other, of which it was death to taste, was admirably adapted to impress on their minds the necessity of implicit obedience to the Divine will, in whatever manner it might be made known to them.

A question has been started of some importance, What would have finally become of men if the first covenant had not been violated? That they would have been all immortal is certain; but it is by no means clear that they would have lived for ever on this earth. On the contrary, it has been an article of very general belief in all ages of the church †, that the garden of Eden was an emblem or type of heaven, and therefore called *Paradise* (see PARADISE); and that under the first covenant, mankind, after a sufficient probation here, were to be translated into heaven without tasting death. This doctrine is not indeed explicitly taught in Scripture; but many things conspire to make it highly probable. The frequent communications between God and man before the fall (M), seem to indicate that Adam was training up for some higher state than the terrestrial paradise. Had he been intended for nothing but to cultivate the ground and propagate his species, he might have been left like other animals to the guidance of his own reason and instincts; which, after the rudiments of knowledge were communicated to him, must surely have been sufficient to direct him to every thing necessary to the comforts of a life merely sensual and rational, otherwise he would have been an imperfect animal. It is obvious too, that this earth, however fertile it may have originally been, could not have afforded the means of subsistence to a race of immortal beings multiplying to infinity. For these reasons, and others which will readily occur to the reader, it seems incontrovertible, that, under the first covenant, either mankind would have been successively translated to some superior state, or would have ceased to propagate their kind as soon as the earth should have been replenished with inhabitants. He who reflects on the promise, that, after the general resurrection, there is to be a new heaven and a new earth, will probably embrace the latter part of the alternative; but that part in its consequences differs not from the former. In the new earth promised in the Christian revelation, nothing is to dwell but righteousness. It will therefore be precisely the same with what we conceive to be expressed by the word heaven; and if under the first covenant this earth was to be converted into a similar place, where, after a certain period, men should never marry nor be given in marriage, but enjoy what divines have called the *beatific vision*, we may confidently affirm, that, had the first covenant been faithfully observed, Adam and his posterity, after a sufficient probation, would all have been translated to some superior state or heaven.

† *Bull's State of Man before the Fall.*

97 had it not been violated, entitled him to heaven,

98 and the gifts of divine grace.

To fit them for that state, the gifts of divine grace seem to have been absolutely necessary. To them it was a state certainly supernatural, otherwise a God of infinite wisdom and perfect goodness would not, for a moment, have placed them in an inferior state. But to enable any creature, especially such a creature as man, whom an ancient philosopher has justly styled ζωον μιμηλικον, to rise above its *nature*, foreign and divine aid is unquestionably requisite; and therefore, though we cannot persuade ourselves that the gifts of the Holy Ghost constituted that image of God in which man was originally made, we agree with Bishop Bull, that these gifts were bestowed on our first parents to enable them to fulfil the terms of the covenant under which they were placed.

On the whole, we think it apparent from the portions of scripture which we have examined, that Adam and Eve were endued with such powers of body and mind as fitted them to exercise dominion over the other animals; that those powers constituted that image of God in which they are said to have been formed; that they received by immediate revelation the first principles of all useful knowledge, and especially of that system which is usually called *natural religion*; that they lived for some time with no other religion, entitled to the natural rewards of piety and virtue, but all the while liable to death; that they were afterwards translated into paradise, where they were placed under a new law, with the penalty of death threatened to the breach of it, and the promise of endless life if they should faithfully observe it; and that they were endued with the gifts of the Holy Ghost, to enable them, if not wanting to themselves, to fulfil the terms of that covenant, which has been improperly termed the *covenant of works*, since it flowed from the mere grace of God, and conferred privileges on man to which the most perfect human virtue could lay no just claim.

99 It is therefore improperly called the covenant of works.

SECT. III. *Of the Fall of Adam, and its Consequences.*

FROM the preceding account of the primeval state of man,

(M) That there were such frequent communications, has been shown to be in the highest degree probable by the late Dr Law bishop of Carlisle. See his *Discourse on the several Dispensations of revealed Religion.*

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100 as it could be violated only by disobedience to one positive command.

man, it is evident that his continuance in the terrestrial paradise, together with all the privileges which he there enjoyed, were made to depend on his observance of one positive precept. Every other duty incumbent on him, whether as resulting from what is called the law of his nature, or from the express command of his God, was as much his duty before as after he was introduced into the garden of Eden; and though the transgression of any law would undoubtedly have been punished, or have been forgiven only in consequence of sincere repentance and amendment, it does not appear that a breach of the *moral* law, or of the commandment respecting the sanctification of the *Sabbath-day*, would have been punished with death, whatever may be the import of that word in the place where it is first threatened. The punishment was denounced only against eating the fruit of the tree of the knowledge of good and evil: For "the Lord God commanded the man, saying, Of every tree of the garden thou mayest freely eat, but of the tree of the knowledge of good and evil thou shalt not eat of it; for in the day that thou eatest thereof thou shalt surely die." To the word *death* in this passage divines have affixed many and different meanings. By some it is supposed to import a separation of the soul and body, while the latter was to continue in a state of conscious existence; by others, it is taken to imply annihilation or a state without consciousness; by some, it is imagined to signify eternal life in torments; and by others a spiritual and moral death, or a state necessarily subject to sin. In any one of these acceptations it denoted something *new* to Adam, which he could not understand without an explanation of the term; and therefore, as it was threatened as the punishment of only one transgression, it could not be the divine intention to inflict it on any other.

101 It was violated,

The abstaining from a particular fruit in the midst of a garden abounding with fruits of all kinds, was a precept which at first view appears of easy observation; and the penalty threatened against the breach of it was, in every sense, awful. The precept, however, was broken notwithstanding that penalty; and though we may thence infer that our first parents were not beings of such absolute perfection as by divines they have sometimes been represented, we shall yet find, upon due consideration, that the temptation by which they were seduced, when taken with all its circumstances, was such as no wise and modest man will think himself able to have resisted. The short history of this important transaction, as we have it in the third chapter of the book of Genesis, is as follows.

"Now the serpent was more subtile than any beast of the field which the Lord God had made; and he said unto the woman, Yea, hath God said, ye shall not eat of every tree of the garden? And the woman said unto the serpent, We may eat of the fruit of the trees of the garden; but of the fruit of the tree which is in the midst of the garden, God hath said, Ye shall not eat of it, neither shall ye touch it, lest ye die. And the serpent said unto the woman, Ye shall not surely die: For God doth know, that on the day ye eat thereof, then your eyes shall be opened, and ye shall be as gods, knowing good and evil. And when the woman *saw* that the tree was good for food, and that it was pleasant to the eyes, and a tree to be desired to make one wise, she took of the fruit thereof, and did eat, and gave also unto her husband with her, and he did eat."

102 in consequence of a most artful temptation,

To the less attentive reader this conversation between the serpent and the woman must appear to begin abruptly; and indeed it is not possible to reconcile it with the natural order of a dialogue, or even with the common rules of grammar, but by supposing the tempter's question, "Yea, hath God said, ye shall not eat of every tree of the garden?" to have been suggested by something immediately preceding either in words or in significant signs. Eve had undoubtedly by some means or other informed the serpent that she was forbidden to eat of the fruit on which he was probably feasting; and that information, whether given in words or in actions, must have produced the question with which the sacred historian begins his relation of this fatal dialogue. We are told that the woman *saw* that the tree was *good for food:* that it was pleasant to the eyes, and a tree to be *desired to make one wise:* but all this she could not have *seen*, had not the serpent eaten of its fruit in her presence. In her walks through the garden, it might have often appeared pleasant to her eyes; but previous to experience she could not know but that its fruit was the most deadly poison, far less could she conceive it capable of conferring wisdom. But if the serpent ate of it before her, and then extolled its virtues in rapturous and intelligible language, she would at once see that it was not destructive of animal life, and naturally infer that it had very singular qualities. At the moment she was drawing this inference, it is probable that he invited her to partake of the delicious fruit, and that her refusal produced the conference before us. That she yielded to his temptation need excite no wonder; for she knew that the serpent was by nature a mute animal, and if he attributed his speech to the virtues of the tree, she might infer, with some plausibility, that what had power to raise the brute mind to human, might raise the human to divine, and make her and her husband, according to the promise of the tempter, become as gods, knowing good and evil. Milton, who was an eminent divine as well as the prince of poets, makes her reason thus with herself.

Great are thy virtues, doubtless, best of fruits,
Tho' kept from man, and worthy to be admir'd;
Whose taste, too long forborn, at first essay
Gave elocution to the mute, and taught
The tongue not made for speech to speak thy praise.
* * * * *
——For us alone
Was death invented? or to us denied
This intellectual food, for beasts reserved?
For beasts it seems: yet that one beast which first
Hath tasted envies not, but brings with joy
The good befallen him, author unsuspect,
Friendly to man, far from deceit or guile.
What fear I then, rather what know to fear
Under this ignorance of good and evil,
Of God or death, of law or penalty?
Here grows the cure of all, this fruit divine,
Fair to the eye, inviting to the taste,
Of virtue to make wise: what hinders then
To reach, and feed at once both body and mind?

Paradise Lost, book ix.

Fall

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Full of these hopes of raising herself to divinity, and not, as has sometimes been supposed, led headlong by a sensual appetite, she took of the fruit and did eat, and gave to her husband with her, and he did eat. The great poet makes Adam delude himself with the same sophistry that had deluded Eve, and infer, that as the serpent had attained the language and reasoning powers of man, they should attain

> Proportional ascent, which could not be
> But to be gods, or angels, demi-gods.

103 and Adam and Eve turned out of paradise.

Thus was the covenant, which, on the introduction of our first parents into paradise, their Creator was graciously pleased to make with them, broken by their violation of the condition on which they were advanced to that supernatural state; and therefore the historian tells us, that "lest they should put forth their hand and take also of the tree of life and eat, and live for ever, the Lord God sent them forth from the garden of Eden to till the ground from whence they were taken (N)." Had they been so sent forth without any farther intimation respecting their present condition or their future prospects, and if the death under which they had fallen was only a loss of consciousness, they would have been in precisely the same state in which they lived before they were placed in the garden of Eden; only their minds must now have been burdened with the inward sense of guilt, and they must have *known* themselves to be subject to death; of which, though not exempted from it by nature, they had probably no *apprehension* till it was revealed to them in the covenant of life which they had so wantonly broken.

God, however, did not send them forth thus hopeless and forlorn from the paradise of delights which they had so recently forfeited. He determined to punish them for their transgression, and at the same time to give them an opportunity of recovering more than their lost inheritance. Calling therefore the various offenders before him, and inquiring into their different degrees of guilt, he began with pronouncing judgment on the serpent in terms which implied that there was mercy for man. "And the Lord God said unto the serpent, Because, thou hast done this, thou art cursed above all cattle, and above every beast of the field: upon thy belly shalt thou go, and dust shalt thou eat all the days of thy life; and I will put enmity between thee and the woman, and between thy seed and her seed: it shall bruise thy head, and thou shalt bruise his heel."

104 The tempter punished.

That this sentence has been fully inflicted on the serpent, no reasoning can be necessary to evince. Every species of that reptile is more hateful to man than any other terrestrial creature; and there is literally a perpetual war between them and the human race. It is remarkable too that the *head* of this animal is the only part which it is safe to bruise. His tail may be bruised, or even cut off, and he will turn with fury and death on his adversary: but the slightest stroke on the head infallibly kills him. That the serpent, or at least the greater part of serpents, go on their belly, every one knows; though it is said *, that in some parts of the east serpents have been seen with wings, and others with feet, and that these species are highly beautiful. If there be any truth in this story, we may suppose that these walking and flying serpents have been suffered to retain their original elegance, that mankind might see what the whole race was before the curse was denounced on the tempter of Eve: but it is certain that most of the species have neither wings nor feet, and that many of the most poisonous of them live in burning deserts, where they have nothing to eat but the dust among which they crawl †.

* Delany's Rev. examined with candour.

† See Bochart and Pliny on Serpents, with Bruce's Travels.

To this degradation of the serpent, infidels have objected, that it implies the punishment of an animal which was incapable of guilt; but this objection is founded in thoughtlessness and ignorance. The elegant form of any species of inferior animals adds nothing to the happiness of the animals themselves: the ass is probably as happy as the horse, and the serpent that crawls as he that flies. Fine proportions attract indeed the notice of man, and tend to impress upon his mind just notions of the wisdom and goodness of the Creator; but surely the symmetry of the horse or the beauty of the peacock is more properly displayed for this purpose than the elegance of the instrument employed by the enemy of mankind. The degradation of the serpent in the presence of our first parents must have served the best of purposes. If they had so little reflection as not yet to have discovered that he was only the instrument with which a more powerful being had wrought their ruin, they would be convinced, by the execution of this sentence, that the forbidden fruit had no power in itself to improve the nature either of man or of beast. But it is impossible that they could be so stupid as this objection supposes them. They doubtles knew by this time that some great and wicked spirit had actuated the organs of the serpent; and that when enmity was promised to be put between its seed and the seed of the woman, that promise was not meant to be fulfilled by serpents occasionally biting the heels of men, and by men in return bruising the heads of serpents! If such enmity, though it has literally taken place, was all that was meant by this prediction, why was not Adam directed to bruise the head of the identical serpent which had seduced his wife? If he could derive any consolation from the exercise of revenge, surely it would be greater from his revenging himself on his own enemy, than from the knowledge that there should be a perpetual warfare between his descendants and the breed of serpents through all generations.

We are told, that when the foundations of the earth were laid, the morning stars sang together, and all the sons of God shouted for joy; and it is at least probable that there would be similar rejoicing when the six days work of creation was finished. If so, Adam and Eve, who were but a little lower than the angels, might be admitted into the chorus, and thus be made acquainted with the existence of good and evil spirits. At all events, we cannot doubt but their gracious and merciful Creator

(N) The ideas which this language conveys are indeed *allegorical*; but they inform us of this, and nothing but this, that *immortal life was a thing extraneous to our nature*, and not put into our paste or composition when first fashioned by the forming hand of the Creator." *Warburton's Divine Legation*, book ix. chap. 1.

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Creator would inform them that they had a powerful enemy; that he was a rebellious angel capable of deceiving them in many ways; and that they ought therefore to be constantly on their guard against his wiles. They must have known too that they were themselves animated by something different from matter; and when they found they were deceived by the serpent, they might surely, without any remarkable stretch of sagacity, infer that their malignant enemy had actuated the organs of that creature in a manner somewhat similar to that in which their own souls actuated their own bodies. If this be admitted, the degradation of the serpent would convince them of the weakness of the tempter when compared with their Creator; and confirm their hopes, that since he was not able to preserve unhurt his own instrument of mischief, he should not be able finally to prevail against them; but that though he had bruised their heels, the promised seed of the woman should at last bruise his head, and recover the inheritance which they had lost. See PROPHECY, N° 9, 10.

105 Sentence passed on Adam and Eve.

Having thus punished the original instigator to evil, the Almighty Judge turned to the fallen pair, and said to the woman, "I will greatly multiply thy sorrow and thy conception: in sorrow shalt thou bring forth children; and thy desire shall be to thy husband, and he shall rule over thee. And unto Adam he said, Because thou hast hearkened unto the voice of thy wife, and hast eaten of the tree of which I commanded thee, saying, Thou shalt not eat of it; cursed is the ground for thy sake; in sorrow shalt thou eat of it all the days of thy life. Thorns also and thistles shall it bring forth unto thee, and thou shall eat the herb of the field. In the sweat of thy face shalt thou eat bread till thou return unto the ground; for out of it wast thou taken: for dust thou art, and unto dust shalt thou return."

Here is a terrible denunciation of toil and misery and death upon two creatures; who, being inured to nothing, and formed for nothing but happiness, must have felt infinitely more horror from such a sentence, than we, who are familiar with death, intimate with misery, and "born to sorrow as the sparks fly upward," can form any adequate conception of. The hardship of it, too, seems to be aggravated by its being severer than what was originally threatened against the breach of the covenant of life. It was indeed said, "In the day thou eatest thereof, thou shalt surely die:" but no mention was made of the woman's incurring sorrow in conception, and in the bringing forth of children; of the curse to be inflicted on the ground; of its bringing forth thorns and thistles instead of food for the use of man; and of Adam's eating bread in sorrow and the sweat of his face till he should return to the dust from which he was taken.

106 An obscure intimation given them of deliverance from it.

These seeming aggravations, however, are in reality instances of divine benevolence. Adam and Eve were now subjected to death; but in the sentence passed on the serpent, an obscure intimation had been given them that they were not to remain for ever under its power. It was therefore their interest, as well as their duty, to reconcile themselves as much as possible to their fate; to wean their affections from this world, in which they were to live only for a time; and to hope, with humble confidence, in the promise of their God, that, upon their departure from it, they should be received into some better state. To enable them to wean their affections from earth, nothing could more contribute than to combine sensual enjoyment with sorrow, and lay them under the necessity of procuring their means of subsistence by labour, hard and often fruitless. This would daily and hourly impress upon their minds a full conviction that the present world is not a place fit to be an everlasting habitation; and they would look forward, with pious resignation, to death, as putting a period to all their woes. Had they indeed been furnished with no ground of hope beyond the grave, we cannot believe that the Righteous Judge of all the earth would have added to the penalty originally threatened. That penalty they would doubtless have incurred the very day on which they fell; but as they were promised a deliverance from the consequences of their fall, it was proper to train them up by severe discipline for the happiness reserved for them in a future state.

After the passing of their sentence, the man and woman were turned out into the world, where they had formerly lived before they were placed in the garden of Eden; and all future access to the garden was for ever denied them. They were not, however, in the same state in which they were originally before their introduction into Paradise: They were now conscious of guilt; doomed to severe labour; liable to sorrow and sickness, disease and death: and all these miseries they had brought, not only on themselves, but also on their unborn posterity to the end of time. It may seem indeed to militate against the moral attributes of God, to inflict misery on children for the sins of their parents; but before any thing can be pronounced concerning the Divine goodness and justice in the present case, we must know precisely how much we suffer in consequence of Adam's transgression, and whether we have ourselves any share in that guilt which is the cause of our sufferings.

107 Doubtful whether men would have been exempted from pain under the first covenant.

That women would have had less sorrow in the bringing forth of children; that we should have been subjected to less toil and exempted from death, had our first parents not fallen from their paradisaical state—are truths incontrovertible by him who believes the inspiration of the Holy Scriptures; but that mankind would in that state have been wholly free from pain and every bodily distress, is a proposition which is not to be found in the Bible, and which therefore no man is bound to believe. The bodies of Adam and Eve consisted of flesh, blood, and bones, as ours do; they were surrounded by material objects as we are; and their limbs were unquestionably capable of being fractured. That their souls should never be separated from their bodies while they abstained from the forbidden fruit, they knew from the infallible promise of him who formed them, and breathed into their nostrils the breath of life; but that not a bone of themselves or of their numerous posterity should ever be broken by the fall of a stone or of a tree, they were not told, and had no reason to expect. Of such fractures, pain would surely have been the consequence; though we have reason to believe that it would have been quickly removed by some infallible remedy, probably by the fruit of the tree of life.

Perhaps it may be said, that if we suppose our first parents or their children to have been liable to accidents of this kind in the garden of Eden, it will be difficult to conceive how they could have been preserved from death, as

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as a stone might have fallen on their heads as well as on their feet, and have at once destroyed the principle of vitality. But this can be said only by him who knows little of the physical world, and still less of the power of God. There are many animals which are susceptible of pain, and yet not easily killed; and man in paradise might have resembled these. At any rate, we are sure that the Omnipotent Creator could and would have preserved him from death; but we have no reason to believe that, by a constant miracle, he would have preserved him from every kind of pain. Indeed, if, under the first covenant, mankind were in a state of probation, it is certainly conceivable that some one individual of the numerous race might have fallen into sin, without actually breaking the covenant by eating the fruit of the tree of knowledge; and such a sinner would undoubtedly have been punished by that God who is of purer eyes than to behold iniquity: but how punishment could have been inflicted on a being exempted from all possibility of pain as well as of death, we confess ourselves unable to imagine. Remorse, which is the inseparable consequence of guilt, and constitutes in our present state great part of its punishment, flows from the fearful looking for of judgment, which the sinner knows shall, in a future state, devour the adversaries of the gospel of Christ; but he, who could neither suffer pain nor death, had no cause to be afraid of future judgement, and was therefore not liable to the tortures of remorse. We conclude, therefore, that it is a mistake to suppose pain to have been introduced into the world by the fall of our first parents, or at least that the opinion contrary to ours has no foundation in the word of God.

108 though they would from death.

Death, however, was certainly introduced by their fall; for the inspired apostle assures us, that in *Adam all die* *; and again, that *through the offence of* ONE *many are dead* †. But concerning the full import of the word *death* in this place, and in the sentence pronounced upon our first parents, divines hold opinions extremely different. Many contend, that it includes death *corporal*, *spiritual* or *moral*, and *eternal*; and that all mankind are subjected to these three kinds of death, on account of their share in the guilt of the original transgression, which is usually denominated *original sin*, and considered as the source of all moral evil.

* Cor. xv. 22.

† Rom. v. 15.

That all men are subjected to death corporal in consequence of Adam's transgression, is universally admitted; but that they are in any sense partakers of his guilt, and on that account subjected to death spiritual and eternal, has been very strenuously denied. To discover the truth is of great importance; for it is intimately connected with the Christian doctrine of redemption. We shall therefore state, with as much impartiality as we can, the arguments commonly urged on each side of this much agitated question.

109 Doctrine of original sin stated.

Those who maintain that all men sinned in Adam, generally state their doctrine thus: "The covenant being made with Adam as a public person, not for himself only but for his posterity, all mankind descending from him by ordinary generation *sinned* in him and fell with him in that first transgression; whereby they are deprived of that original righteousness in which he was created, and are utterly indisposed, disabled, and made opposite to all that is spiritually good, and wholly inclined to all evil, and that continually; which is commonly called *original sin*, and from which do proceed all actual transgressions, so as we are by nature children of wrath, bond-slaves to Satan, and justly liable to all punishments in this world and in that which is to come, even to everlasting separation from the comfortable presence of God, and to most grievous torments in soul and body, without intermission, in hell fire for ever."

That which in this passage we are first to examine, is the sentence which affirms all mankind descending from Adam by ordinary generation to have *sinned* in him and fallen with him in his first transgression; the truth of which is attempted to be proved by various texts of Holy Scripture. Thus St Paul says expressly, that "by one man sin entered into the world, and death by sin; and so death passed upon all men, for that *all have sinned*. But not as the offence, so also is the free gift. 110
For if, through the *offence* of *one*, *many* be *dead*; much more the grace of God, and the gift by grace, which is by one man, Jesus Christ, hath abounded unto many; and not as it was by one that sinned, so is the gift (for the *judgment* was by *one* unto *condemnation*); but the free gift is of many offences unto justification. For if, by one man's offence, death reigned by one; much more they, who receive the abundance of grace and of the gift of righteousness, shall reign in life by one, Jesus Christ. Therefore as, by the *offence of one*, *judgment* came upon *all men* to *condemnation*; even so, by the righteousness of One, the free gift came upon all men unto justification of life. For as by one man's disobedience *many were made sinners*; so by the obedience of one shall many be made righteous *." In this passage the apostle assures us, that all upon whom death hath passed have *sinned*; but death hath passed upon infants, who could not commit actual sin. Infants therefore must have sinned in Adam, since death hath passed upon them; for death "is the wages only of sin." He tells us likewise, that by the offence of one, judgment came upon all men to condemnation; and therefore since the Righteous Judge of heaven and earth never condemns the innocent with the wicked, we must conclude, that all men partake of the guilt of that offence for which judgment came upon them to condemnation. These conclusions are confirmed by his saying expressly, that "by one man's disobedience many (*i. e.* all mankind) were *made sinners*;" and elsewhere†, that "there is none righteous, no *not one*;" and that his Ephesian converts "were dead in trespasses and sins, and were by *nature* children of wrath even as *others*." The same doctrine, it is said, we are taught by the inspired writers of the Old Testament. Thus Job, expostulating with God for bringing into judgment with him such a creature as man, says, "Who can bring a clean thing out of an unclean? Not one." And Eliphaz, reproving the patient patriarch for what he deemed presumption, asks ‡, "What is man that he should be clean, or he who is born of a woman that he should be righteous?" From these two passages it is plain, that Job and his unfeeling friend, though they agreed in little else, admitted as a truth unquestionable, that man inherits from his parents a sinful nature, and that it is impossible for any thing born of a woman by ordinary generation to be righteous. The psalmist talks the very same language; when acknowledging his transgressions, he says ||, "Behold I was shapen in iniquity, and in sin did my mother conceive me."

Argument for it.

* Rom. v. 12, 15—16.

† Rom. ii. 10. and Eph. ii. 1. and 3.

‡ Job xiv. 4. and xv. 14.

|| Psalm li. 5.

Having

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Adam's guilt imputed to his posterity.

Having thus proved the fact, that all men are made sinners by Adam's disobedience, the divines, who embrace this side of the question, proceed to inquire how they can be partakers in guilt which was incurred so many ages before they were born. It cannot be by imitation; for infants, according to them, are involved in this guilt before they be capable of imitating any thing. Neither do they admit that sin is by the apostle put for the consequences of sin, and many said to be made sinners by one man's disobedience, because by that disobedience they were subjected to death, which is the wages of sin. This, which they call the doctrine of the Arminians, they affirm to be contrary to the whole scope and design of the context; as it confounds together sin and death, which are there represented, the one as the cause, and the other as the effect. It likewise exhibits the apostle reasoning in such a manner as would, in their opinion, disgrace any man of common sense, and much more an inspired writer; for then the sense of these words, "Death hath passed upon all men, for that all have sinned," must be, death has passed upon all men, because it hath passed upon all men; or, all men are obnoxious to death, because they are obnoxious to it. The only way therefore, continue they, in which Adam's posterity can be made sinners through his disobedience, is by the IMPUTATION of his disobedience to them; and his imputation is not to be considered in a *moral* sense, as the action of a man committed by himself, whether good or bad, is reckoned into him as his own; but in a *forensic* sense, as when one man's debts are in a legal way placed to the account of another. Of this we have an instance in the apostle Paul, who said to Philemon concerning Onesimus, "If he hath wronged thee, or oweth thee any thing (ελλογει), let it be imputed to me," or placed to and put on my account. And thus the posterity of Adam are made sinners by his disobedience; that being imputed to them and put to their account, as if it had been committed by them personally, though it was not.

Some few divines of this school are indeed of opinion, that the phrase, "By one man's disobedience many were made sinners," means nothing more than that the posterity of Adam, through his sin, derive from him a corrupt nature. But though this be admitted as an undoubted truth, the more zealous abettors of the system contend, that it is not the whole truth. "It is true (say they) that all men are made of one man's blood, and that blood tainted with sin; and so a clean thing cannot be brought out of an unclean. What is born of the flesh is flesh, carnal and corrupt: every man is conceived in sin and shapen in iniquity; but there is a difference between being *made sinners* and *becoming* sinful. The one respects the *guilt*, the other the *pollution* of nature; the one is previous to the other, and the foundation of it. Men receive a corrupt nature from their immediate parents; but they are made sinners, not by any act of their disobedience, but only by the imputation of the sin of Adam."

To illustrate this doctrine of imputed sin, they observe that the word κατεσταθησαν, used by the apostle, signifies *constituted* in a judicial way, ordered and appointed in the dispensation of things that so it should be; just as Christ was made sin or a sinner by imputation, or by that constitution of God which laid upon him the sins of all his people, and dealt with him as if he had been the guilty person. That this is the sense of the passage, they argue further from the punishment inflicted on men for the sin of Adam. The punishment threatened to that sin was death; which includes death corporal, moral, and eternal. Corporal death, say they, is allowed by all to be suffered on account of the sin of Adam; and if so, there must be guilt, and that guilt made over to the sufferer, which can be done only by *imputation*. A moral death is no other than the loss of the image of God in man, which consisted in righteousness and holiness; and particularly it is the loss of original righteousness, to which succeeded unrighteousness and unholiness. It is both a sin and a punishment for sin; and since it comes on all men as a punishment, it must suppose preceding sin, which can be nothing but Adam's disobedience; the guilt of which is made over to his posterity by *imputation*. This appears still more evident from the posterity of Adam being made liable to eternal death in consequence of his transgression; for the wages of sin is death, even death eternal, which never can be inflicted on guiltless persons. But from the passage before us we learn, that "by the offence of *one* judgment came upon all men to condemnation;" and therefore the guilt of that offence must be reckoned to all men, or they could not be justly condemned for it. That Adam's sin is imputed to his posterity, appears not only from the words, "by one man's disobedience many were made sinners;" but likewise from the opposite clause, "so by the obedience of One shall many be made righteous;" for the many ordained to eternal life, for whom Christ died, are made righteous, or justified, only through the imputation of his righteousness to them; and therefore it follows, that all men are made sinners only through the imputation of Adam's disobedience.

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the punishment of imputed guilt.

To this doctrine it is said to be no objection that Adam's posterity were not in being when his sin was committed; for though they had not then actual being, they had yet a virtual and representative one. They were in him both *seminally* and *federally*, and sinned in him *; just as Levi was in the loins of Abraham, and paid in him tithes to Melchizedeck †. From Adam they derive a corrupt nature; but it is only from him, as their federal head, that they derive a share of his guilt, and are subjected to his punishment. That he was a federal head to all his posterity, the divines of this school think evident from his being called a figure of Christ ‡; and the first Adam described as natural and earthly, in contradistinction to Christ the second Adam described as spiritual and the Lord from heaven; and from the punishment threatened against his sin being inflicted not on himself only, but on all his succeeding offspring. He could not be a figure of Christ, say they, merely as a man; for all the sons of Adam have been men as well as he, and in that sense were as much figures of Christ as he; yet Adam and Christ are constantly contrasted, as though they had been the only two men that ever existed, because they were the only two heads of their respective offspring. He could not be a figure of Christ on account of his extraordinary production; for though both were produced in ways uncommon, yet each was brought into the world in a way peculiar to himself. The first Adam was formed of the dust of the ground; the second, though not begotten by a man, was born of a woman. They did not therefore resemble each other in the manner of their formation, but in their office as

* Rom. v. 12.

† Heb. vii. 9, 10.

113
Adam a federal head to his posterity.

‡ Rom. v. 14.

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covenant-heads; and in that alone the comparison between them is exact.

114 No cause of complaint in this constitution of things.

Nor have any of the posterity of Adam, it is said, reason to complain of such a procedure. Had he stood in his integrity, they would have been, by his standing, partakers of all his happiness: and therefore should not murmur at receiving evil through his fall. If this do not satisfy, let it be considered, that since God, in his infinite wisdom, thought proper that men should have a head and representative, in whose hands their good and happiness should be placed, none could be so fit for this high station as the common parent, made after the image of God, so wise, so holy, just, and good. Lastly, to silence all objections, let it be remembered, that what God gave to Adam as a federal head, relating to himself and his posterity, he gave as the Sovereign of the universe, to whom no created being has right to ask, "What dost thou * ?"

*See *Gill's Body of Divinity*.

115 St Augustine the author of this doctrine.

Such are the consequences of Adam's fall, and such the doctrine of original sin, as maintained by the more rigid followers of Calvin. That great reformer, however, was not the author of this doctrine. It had been taught so early as in the beginning of the fifth century, by St Augustine, the celebrated bishop of Hippo (see AUGUSTINE); and the authority of that father had made it more or less prevalent in both the Greek and Roman churches long before the Reformation. Calvin was indeed the most eminent modern divine by whom it has been held in all its rigour; and it constitutes one great part of that theological system, which, from being taught by him, is now known by the name of *Calvinism*.

116 Objections to it,

But if it was as sovereign of the universe that God gave to Adam what he received in paradise relating to himself and his posterity, Adam could in no sense of the words be a federal head; because, upon this supposition, there was no covenant. The Sovereign of the universe may unquestionably dispense his benefits, or withhold them, as seems expedient to his infinite wisdom; and none of his subjects or creatures can have a right to say to him, What dost thou? But the dispensing or withholding of benefits is a transaction very different from the entering into covenants; and a judgment is to be formed of it on very different principles. Every thing around us proclaims that the Sovereign of the universe is a being of perfect benevolence; but, say the disciples of the school now under consideration, the dispensation given to Adam in paradise was so far from being the offspring of benevolence, that, as it is understood by the followers of Calvin, it cannot possibly be reconciled with the eternal laws of equity. The self-existent and all-sufficient God might or might not have created such a being as man; and in either case there would have been no reason for the question "What dost thou?" But as soon as he determined to create him capable of happiness or misery, he would not have been either benevolent or just, if he had not placed him in a state where, by his own exertions, he might, if he chose, have a greater share of happiness than of misery, and find his existence, upon the whole, a blessing. They readily acknowledge, that the existence of any created being may be of longer or shorter duration, according to the good pleasure of the Creator; and therefore they have no objection to the apostolic doctrine, that "in Adam all die:" for immortality being not a debt, but a *free gift*, may be bestowed on any terms, and with perfect justice withdrawn when these terms are not complied with. Between death, however, as it implies a loss of consciousness, and the extreme misery of eternal life in torments, there is an immense difference. To death all mankind might justly be subjected through the offence of one; because they had originally no claim to be exempted from it, though that one and they too had remained for ever innocent: but eternal life in torments is a punishment which a God of justice and benevolence can never inflict but upon personal guilt of the deepest die. That we can personally have incurred guilt from a crime committed some thousands of years before we were born, is impossible. It is indeed a notion as contrary to Scripture as to reason and common sense: for the apostle expressly informs us *, "that sin is the transgression of some law;" and the sin of Adam was the transgression of a law which it was never in our power either to observe or to break. Another apostle † assures us, that "where no law is, there is no transgression"; but there is now no law, nor has been any these 5000 years, forbidding mankind to eat of a particular fruit; for, according to the Calvinists themselves ‡, Adam had no sooner committed his first sin, by which the covenant with him was broken, than he ceased to be a covenant-head. This law given him was no more; the promise of life by it ceased; and its sanction, death, took place. But if this be so, how is it possible that his unborn posterity should be under a law which had no existence, or that they should be in a worse state in consequence of the covenant being broken, and its promise having ceased, than he himself was before the covenant was first made? He was originally a mortal being, and was promised the supernatural gift of immortality on the single condition of his abstaining from the fruit of the tree of knowledge of good and evil. From that fruit he did not abstain; but by eating it fell back into his natural state of mortality. Thus far it is admitted that his posterity fell with him: for they have no claim to a supernatural gift which he had forfeited by his transgression. But we cannot admit, say the divines of this school, that they fell into his guilt; for to render it possible for a man to incur guilt by the transgression of a law, it is necessary not only that he have it in his power to keep the law, but also that he be capable of transgressing it by a *voluntary* deed. But surely no man could be capable of voluntarily eating the forbidden fruit 5000 years before he himself or his volitions existed. The followers of Calvin think it a sufficient objection to the doctrine of transubstantiation, that the same numerical body cannot be in different places at the same instant of time. But this ubiquity of body, say the remonstrants, is not more palpably absurd, than the supposition that a man could exert volitions before he or his will had any existence.

117 as inconsistent with the justice of God,

118 the scripture, and the nature of things.

* 1 John iii. 4.

† Rom. iv. 15.

‡ *Gill's Body of Divinity*, b. iii. ch. 10.

119 The word IMPUTATION removes no difficulties.

Nor will the introduction of the word *imputation* into this important question remove a single difficulty. For what is that we mean by saying that the sin of Adam is imputed to his posterity? Is the guilt of that sin transferred from him to them? So surely thought Dr Gill, when he said that it *is made over to them*. But this is the same absurdity as the making over of the sensible qualities of bread and wine to the internal substance of our Saviour's body and blood! This imputation either found the posterity of Adam guilty of his sin, or it made them so. It could not find them guilty for

for the reason already assigned; as well as because the apostle says expressly, that for the offence of *one* judgement came upon *all* men, which would not be true had *all* offended. It could not make them guilty; for this reason, that if there be in physics or metaphysics a single truth self-evident, it is, that the numerical powers, actions, or qualities, of one being cannot possibly be transferred to another, and be made its powers, actions, or qualities. Different beings may in distant ages have qualities of the same kind; but as easily may 4 and 3 be made equal to 9, as two beings be made to have the same identical quality. In Scripture we nowhere read of the actions of one man being imputed to another. "Abraham (we are told) believed in God, and it was counted to him for righteousness;" but it was his *own* faith, and not the faith of another man, that was so counted. "To him that worketh not, but believeth, his faith (not another's) is imputed for righteousness." And of our faith in him that raised Christ from the dead, it is said, that "it shall be imputed, not to our fathers or our children, but to us for righteousness."

120 Meaning of that word in Scripture.

When this phrase is used with a negative, not only is the man's own personal sin spoken of, but the non-imputation of that sin means nothing more but that it brings not upon the sinner condign punishment. Thus when Shemei "said unto David, Let not my lord *impute* iniquity unto me;" it could not be his meaning that the king should not think that he had offended; for with the same breath he added, Neither do thou remember that which thy servant *did perversely*, the day that my lord the king went out of Jerusalem, that the king should take it to his *heart*. For thy servant doth *know* that *I have sinned*." Here he plainly confesses his sin, and declares, that by intreating the king not to *impute it to him*, he wished only that it should not be so remembered as that the king should take it to heart, and punish him as his perverseness deserved. When therefore it is said †, that "God was in Christ reconciling the world to himself, not imputing to them their iniquities, the meaning is only that for Christ's sake he was pleased to exempt them from the punishment due to their sins. In like manner, when the prophet, foretelling the sufferings of the Messiah, says, that "the Lord laid on him the iniquity of us all," his meaning cannot be, that the Lord by *imputation* made his immaculate Son guilty of all the sins that men have ever committed; for in that case it would not be true that the "just suffered for the unjust," as the apostle expressly teaches ‡: but the sense of the verse must be, as Bishop Coverdale translated it, "through him the Lord pardoneth all our sins." This interpretation is countenanced by the ancient version of the Seventy, *και Κυριος παρεδωκεν αυτον ταις αμαρτιαις ημων*; words which express a notion very different from that of imputed guilt. The Messiah was, without a breach of justice, delivered for sins of which he had voluntarily offered to pay the penalty; and St Paul might have been justly charged by Philemon with the debts of Onesimus, which he had desired might be placed to his account. Had the apostle, however, expressed no such desire, surely Philemon could by no deed of his have made him liable for debts contracted by another; far less could he by *imputation*, whatever that word may mean, have made him virtually concur in the contracting of those debts. He could not have been justly subjected to suffering without his own consent; and he could not possibly have been made guilty of the sins of those for whom he suffered.

† 2 Cor. v. 19.

‡ 1 Peter iii. 18.

The doctrine of imputed guilt, therefore, as understood by the Calvinists, is, in the opinion of their opponents, without foundation in Scripture, and contrary to the nature of things. It is an impious absurdity (say they), to which the mind can never be reconciled by the hypothesis, that all men were in Adam both seminally and federally, and sinned in him, as Levi paid tithes to Melchizedeck in the loins of Abraham. The apostle, when he employs that argument to lessen in the minds of his countrymen the pride of birth and the lofty opinions entertained of their priesthood, plainly intimates, that he was using a bold figure, and that Levi's paying tithes is not to be understood in a strict and literal sense. "Now consider (says he) how great this man was, unto whom even the patriarch Abraham gave the tenth of the spoils. And, *as I may so say*, Levi also, who receiveth tithes, paid tithes in Abraham: for he was yet in the loins of his father when Melchizedeck met him." This is a very good argument to prove that the Levitical priesthood was inferior in dignity to that of Melchizedeck; and by the apostle it is employed for no other purpose. Levi could not be greater than Abraham, and yet Abraham was inferior to Melchizedeck. This is the whole of St Paul's reasoning, which lends no support to the doctrine of original sin, unless it can be shown that Levi and all his descendants contracted from this circumstance such a strong propensity to the *paying* of tithes, as made it a matter of extreme difficulty for them, in every subsequent generation, to comply with that part of the divine law which constituted them *receivers* of tithes. That all men were seminally in Adam, is granted; and it is likewise granted that they may have derived from him, by ordinary generation, diseased and enfeebled bodies: but it is as impossible to believe that moral guilt can be transmitted from father to son by the physical act of generation, as to conceive a scarlet colour to be a cube of marble, or the sound of a trumpet a cannon ball. That Adam was as fit a person as any other to be entrusted with the good and happiness of his posterity, may be true; but there is no fitness whatever, according to the Arminians, in making the everlasting happiness or misery of a whole race depend upon the conduct of any fallible individual. "That any man should so represent me (says Dr Taylor *), that when he is guilty, I am to be reputed guilty; when he transgresses, I shall be accountable and punishable for his transgression; and this before I am born, and consequently before I am in any capacity of knowing, helping, or hindering, what he doth: all this every one who useth his understanding must clearly see to be false, unreasonable, and altogether inconsistent with the truth and goodness of God." And that no such appointment ever had place, he endeavours to prove, by showing that the texts of Scripture upon which is built the doctrine of the Calvinists respecting original sin, will each admit of a very different interpretation.

121 Moral guilt cannot be transmitted from father to son.

* *Doctrine of Original Sin*, part iii.

122 The several texts on which this doctrine is built capable of a different interpretation.

One of the strongest of these texts is Romans v. 19. which we have already quoted, and which our author thus explains. He observes, that the apostle was a Jew, familiarly acquainted with the Hebrew tongue; that he wrote his epistle as well for the use of his own countrymen residing in Rome, as for the benefit of the Gentile converts; and that though he made use of the Greek language, tion it refers to our mortality, they think plain from the context; and Dr Taylor adds *, with some plausibility, that if the words refer to the guilt which we are supposed to derive from Adam, they will prove too much to serve the common scheme of original sin. They will prove that our natural and inherent pravity, so far from rendering us fit objects of wrath, may be urged as a reason why God should not even bring us into judgement; for the patriarch's whole expostulation runs thus, "Dost thou open thine eyes upon such a one, and bringest me into judgment with thee? Who can bring a clean thing out of an unclean?"

* *Scripture Doctrine*, part ii.

The other text, quoted from the same book, they think still less to the purpose; for Eliphaz is evidently contrasting the creature with the Creator; in comparison with whom, he might well say, without alluding to original guilt, "what is man that he should be clean? and he who is born of a woman that he should be righteous? Behold he putteth no trust in his saints; yea the *heavens* are not clean in his sight. How much more abominable and filthy is man, who drinketh iniquity like water?" He does not say, who derives by birth an iniquitous nature; for he knew well, that as we are born, we are the pure workmanship of God, "whose hands have fashioned and formed every one of us;" but "who *drinketh* iniquity like water," who maketh himself iniquitous by running headlong into every vicious practice.

Of the text quoted from the fifty-first psalm in support of the doctrine of original sin, Dr Taylor labours †, by a long and ingenious criticism, to prove that our translators have mistaken the sense. The word which they have rendered *shapen*, he shows to be used once by Isaiah, and twice in the book of Proverbs, to signify *brought forth;* and that which is rendered *conceived me*, is never, he says, employed in scripture to denote human conception. In this last remark, however, he is contradicted by a great authority, no less indeed than that of Mr Parkhurst ‡, who says, that the LXX constantly render it by κισσαω or εγκισσαω, and the Vulgate generally by *concipio*. Without taking upon us to decide between these two eminent Hebrew scholars, we shall only observe, that upon one occasion || it certainly denotes ideas much grosser than those which the Psalmist must have had of his mother's conception; and that there, at least, Dr Taylor properly translates it, *incalescebant*, adding, "de hoc vero incalescendi genere loqui Davidem nemo sanus existimare potest. Matrem enim incaluisse, aut ipsum calefecisse eo modo quo incalescerent Jacobi pecudes Regem dicere, prorsus indecorum et absurdum." He contends, however, that the original force of the word is *to be hot*, and that it is applied to *conception*, to *resentment*, to *warmth* by which the body is nourished, to *idolaters* in love with idols, and to the heat of metals. The heat of idolaters, of resentment, and of metals, are evidently foreign to the Psalmist's purpose; and the idea conveyed by the word *incalescere* being set aside for the reasons already assigned, there remains only the warmth by which the body is nourished, and of that warmth our ardour is confident that David spoke.

† *Ubi supra.*

‡ See his *Lexicon* on *the word* יחם.

|| Gen. xxx. 38, 39, 40, compared with xxxi. 10.

If this criticism be admitted, the whole verse will then run thus: "Behold I was born in iniquity, and in sin did my mother nurse me;" which hath no reference to the original formation of his constitution, but is a periphrasis of his being a *sinner from the womb*, and means nothing more than that he was a *great sinner*, or had contracted *early habits* of sin. He no more designed to signify in this verse, that by ordinary generation he had a nature conveyed to him which was "utterly indisposed, disabled, and opposite to all that is spiritually good, and wholly and continually inclined to evil," than he meant in another * to signify strictly and properly that "the wicked are estranged from the womb, and TELL LIES as soon as they are born;" or that Job meant to signify †, that from the moment he came from his mother's womb he had been a guide to the widow and a succour to the fatherless. All these are hyperbolical forms of expression; which, though they appear strained, and perhaps extravagant, to the phlegmatic inhabitants of Europe, are perfectly suited to the warm imaginations of the orientals, and to the genius of eastern languages. They mean not that Job was *born* with *habits of virtue*, that the wicked actually *walked*, and *spoke*, and *spoke lies* from the instant of their *birth*, or that the Psalmist was really *shapen* in *sin* and *conceived in iniquity*. This last sentence, if interpreted literally, would indeed be grossly impious: it would make the inspired penman throw the whole load of his iniquity and sin from off himself upon *him* who shaped, and upon *her* who conceived him; even upon that God "whose hands had made him and fashioned him, and whom he declares that he will praise for having made him fearfully and wonderfully," and upon that parent who conceived him with sorrow, and brought him forth with pain, and to whom the divine law commanded him to render honour and gratitude. "But if, after all (says Dr Taylor ‡), you will adhere to the literal sense of the text for the common doctrine of *original sin*, show me any good reason why you ought not to admit the literal sense of the text, *this is my body*, for *transubstantiation?* If you say, it is absurd to suppose that Christ speaks of his real natural body; I say, it is likewise absurd to suppose that the Psalmist speaks of his being really and properly shapen in iniquity, and conceived in sin. If you say, that the sense of the words *this is my body* may be clearly explained by other texts of scripture where the like forms of speech are used; I say, and have shown, that the Psalmist's sense may as clearly and evidently be made out by parallel texts, where you have the like kind of expression. If you say that transubstantiation is attended with consequences hurtful to piety, I say that the common doctrine of original sin is attended with consequences equally hurtful; for it is a principle apparently leading to all manner of iniquity, to believe that sin is natural to us, that it is interwoven and ingrafted into our very constitution from our conception and formation in the womb."

* Ps. lviii. 3.

† Job xxxi. 18.

‡ *Scripture Doctrine*, part ii.

123 Consequences of eating the forbidden fruit, according to the Arminians.

The Arminians having thus, as they think, proved that the posterity of Adam, are not in any sense rendered guilty by his sin, contend, that the death threatened against his eating of the forbidden fruit, and which, in consequence of his transgression, came upon all men, can mean nothing more than the loss of that vital principle which he received when God breathed into his nostrils the breath of life, and he became a living soul. Every thing beyond this is pure conjecture, which has no foundation in the scriptures of truth, and is directly contrary to all the notions of right and wrong which we

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we have been able to acquire from the study of those very scriptures. It is not conceivable from any thing in the history, that Adam could understand it of the loss of any other life than that which he had lately received, for no other life is spoken of to which the threatened death can be opposed; and in such circumstances, it was strange indeed, if by the word *death* he understood either eternal life in misery, or a necessity of continuing in sin. The sense therefore of the threatening, say they, is this: "I have formed thee of the dust of the ground, and breathed into thy nostrils the breath of life; and thus thou art become a living soul. But if thou eatest of the fruit of the tree of knowledge of good and evil, thou shalt cease to be a living soul; for I will take from thee the breath of life, and thou shalt return to the dust of which thou wast formed."

124 Some of them admit the depravity of human nature,

Thus far the Arminians of the present day are agreed in opposing the doctrine of the rigid Calvinists, and in stating their own notions of the consequences of Adam's fall; but from that event their adversaries deduce one consequence, which some of them admit and others deny. It is said that though we cannot possibly be partakers in Adam's guilt, we yet derive from him a moral taint and infection, by which we have a natural propensity to sin; that having lost the image of God, in which he was created, Adam begat sons in his own image; and in one word, that the sensual appetites of human nature were inflamed, and its moral and intellectual powers greatly weakened by the eating of the forbidden fruit. The heathens themselves acknowledged and lamented this depravity; though they were ignorant of the source from which it sprung. The scriptures assert it, affirming that no man can be born pure and clean; that whatever is born of the flesh, or comes into the world by ordinary generation, is flesh, carnal and corrupt; that the imagination of the thoughts of man's heart is only evil continually; that the heart is deceitful above all things and desperately wicked; and that out of it proceeds all that is vile and sinful *.

125 and illustrate it upon principles of natural knowledge,

This depravity of human nature, thus clearly deducible from scripture, and confirmed by the testimony of ages, an ingenious writer of the moderate Arminian school undertakes to illustrate upon the principles of natural knowledge. "We know (says he †), that there are several fruits in several parts of the world of so noxious a nature as to destroy the best human constitution on earth. We also know that there are some fruits in the world which inflame the blood into fevers and frenzies; and we are told that the Indians are acquainted with a certain juice, which immediately turns the person who drinks it into an idiot, leaving him at the same time in the enjoyment of his health and all the powers of his body. Now I ask Whether it be not possible, nay, whether it be not rational, to believe, that the same fruit, which, in the present infirmity of nature, would utterly destroy the human constitution, might, in its highest perfection, at least disturb, impair, and disease it? and whether the same fruit, which would now inflame any man living into a fever or frenzy, might not inflame Adam into a turbulence and irregularity of passion and appetite; and whether the same fluids, which inflame the blood into irregularity of passion and appetite, may not naturally produce infection and impair the constitution? That the forbidden fruit had the effect to produce irregularity of appetite, appears as from other proofs, so I think fully and clearly from the covering which Adam and Eve made use of soon after their offence; for there is no imaginable reason for that covering but one, and that one sufficiently demonstrates, that irregularity and violence of appetite, independent of the dominion of reason, was the effect of their offence. But the fruit which inflamed the sensual appetite might likewise debase their rational powers; for I ask, whether the same juice, which now affects the brain of an ordinary man so as to make him an idiot, might not affect the brain of Adam so as to bring his understanding down to the present standard of ordinary men? And if this be possible, and not absurd to be supposed, it is evident that the subsequent ignorance and corruption of human nature may be clearly accounted for upon these suppositions; nay, I had almost said upon any one of them. For it is universally known, that the infections and infirmities of the father affect the children yet in his loins; and if the mother be equally infected, must, unless removed by proper remedies, affect their posterity to the end of the world, or at least till the race become extinct. Therefore why all mankind might not by their first father's sin be reduced to the same condition of infirmity and corruption with himself, especially when the mother was equally infirm, and infected, I believe no man any way skilled in the knowledge of nature will so much as pretend to say."

This account of the corruption of human nature seems to be generally adopted by moderate divines, as well among the Calvinists as among the Arminians; but by the high-fliers in both schools it is rejected, on different principles indeed, with great indignation. The zealous Calvinist contends, that this hereditary corruption is not to be accounted for or explained by any principle of physical science, since it is part of that punishment which was inflicted on the race for their original sin. If we were not partakers of Adam's guilt, say they, we should not have been partakers of his corruption. The one is previous to and the foundation of the other. The depravity of human nature is a punishment for sin; and so it was threatened to Adam, and came upon him as such, and so to all his posterity, by the *ordination* and *appointment of God*; for which there can be no other foundation but the imputation of Adam's disobedience to them, nor can any thing else vindicate the righteousness of God. For if the law of nature was sufficient, why should this *original* taint infect men rather than the sins of their immediate parents ‡."

126 whilst other object the doctrine,

The more violent Arminians, on the other hand, deny that we inherit any moral taint whatever from Adam, or that the rational powers of our minds are naturally weaker than his were. Of that wonderful degree of perfection which is usually attributed to the first pair, they find no evidence in scripture. All that we learn of them, say they, is, that they fell from a state of exquisite happiness by yielding to a temptation less powerful by far than some others which many of their degenerate sons have successfully resisted. "I leave you to judge (says Dr Taylor §), whether Joseph, when he resisted the solicitations of his mistress, and Moses when he refused to be called the son of Pharaoh's daughter, choosing rather to suffer affliction with the people of God than to enjoy the pleasures of sin for a season, esteeming the reproach of true religion greater riches than the treasures of Egypt, did not exhibit proofs of regularity

* Job xiv. 4. John iii. 6. Rom. iii. 5. Jer. xvii. 9. Mat. xv. 19.

† *Delany's Revelation examined with candour*, Dissert. 1. and 7.

‡ *Gill's Body of Divinity*, book iii. ch. 10, 11, and 13.

§ *Scripture Doctrine*, &c.

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regularity of passions and appetites equal at least to what Adam displayed in the garden of Eden. When the three young men mentioned in the book of Daniel submitted to be burnt alive in a fiery furnace rather than worship Nebuchadnezzar's golden image; when Daniel himself resolved, rather than conceal the worship of God for one month only of his life, to be torn in pieces by hungry lions; and, to come nearer to our own times, when numbers of men and women, during the reign of Mary queen of England, chose rather to be burnt at a stake than renounce the reformed religion and embrace the errors of popery—surely all these persons exhibited a virtue, a faith in God and a steady adherence to what they believed to be the truth, far superior to what Adam displayed, when his wife gave him of the forbidden fruit, and he did eat." If it be said that these persons were supported under their trials by the grace of God strengthening them, the same will be said of Adam. He was undoubtedly supplied with every aid from the spirit of grace which was necessary to enable him to fulfil his duty; for being designed for more than mere animal life, even for the refined enjoyments of heaven, there is every reason to believe, as we have already observed, that he was put under the guidance of the Holy Ghost, to train him for that supernatural state of felicity. These communications of the spirit would of course be withdrawn when he forfeited his right to those privileges, on account of which they were originally vouchsafed to him; but that any positive malignity or taint was infused into his nature, that his mere rational powers were weakened, or his appetites inflamed by the forbidden fruit, there is no evidence to be found in scripture, or in the known constitution of things. The attributing of this supposed hereditary taint to the noxious qualities of the forbidden fruit, is a whimsical hypothesis, which receives no countenance from any well authenticated

127 and deem the physical illustration of it whimsical;

fact in natural history. After the numberless falsehoods that have been told of the poison tree of Java, something more would be requisite than the common evidence of a lying voyager to give credit to the qualities of the Indian tree, of which the fruit instantly turns the wisest man into an idiot: and yet for this singular story our ingenious author vouchsafes not even that evidence, slight as it generally is. The inference drawn from the covering used by our first parents is contradicted by every thing that we know of human nature; for surely no man inflamed to the utmost with the fire of animal love, ever turned his eyes from a naked beauty ready and eager to receive him to her embrace. Yet this, it seems, was the behaviour of Adam and Eve in such a state! According to our author, the juice of the forbidden fruit had rendered their carnal appetites violent and independent of reason; according to the scripture, they were both naked; and as they were husband and wife, there was no law prohibiting them from gratifying these inflamed appetites. In such circumstances, how did they conduct themselves: One would naturally imagine that they immediately retired to some shady grove, and pleased themselves in all the soft dalliances of wedded love. Their conduct however, was very different. We are told, that "they sewed fig-leaves together, and made themselves aprons to cover their nakedness:" And this transaction is brought as a proof of the impetuosity of their carnal appetites. The truth is, that the carnal appetite appears not to be naturally more violent than is necessary to answer the end for which it was implanted in the human constitution. Among savages the desires of animal love are generally very moderate; and even in society they have not often, unless inflamed by the luxurious arts of civil life, greater strength than is requisite to make mankind attend to the continuation of their species. In the decline of empires highly polished, where the difference of rank and opulence is great, and where every man is ambitious of emulating the expence of his immediate superiors, early marriages are prevented by the inability of most people to provide for a family in a way suitable to what each is pleased to consider as his proper station; and in that state of things the violence of animal love will indeed frequently produce great irregularities. But for that state of things, as it was not intended by the Author of nature, it is perhaps unreasonable to suppose that provision should be made; and yet we believe it will be found, upon due consideration, that if the desires of animal love were less violent than they are, the general consequences would be more pernicious to society than all the irregularities and vices which these desires now accidentally produce; for there would then be no intercourse between the sexes whatever except in the very highest stations of life. That our constitution is attended with many sensual appetites and passions, is true; and that there is a great danger of their becoming excessive and irregular in a world so full of temptation as ours is, is also true; but there is no evidence that all this is the consequence of Adam's fall, and far less that it amounts to a *natural propensity* 128

128 maintaining that we have no natural propensity to sin.

to sin. For I presume (says Dr Taylor), that by a natural propensity is meant a necessary inclination to sin, or that we are necessarily sinful from the original bent and bias of our natural powers. But this must be false; for then we should not be sinful at all, because that which is necessary, or which we cannot help, is not sin. That we are weak and liable to temptation, is the will of God holy and good, and for glorious purposes to ourselves; but if we are wicked, it must be through our own fault, and cannot proceed from any constraint, or necessity, or taint in our constitution."

Thus we have given as full and comprehensive a view as our limits will permit of the different opinions of the Calvinists and Arminians respecting the consequences of Adam's fall. If we have dwelt longer upon the scheme of the latter than of the former, it is because every Arminian argument is built upon criticism, and appeals to the original text; whilst the Calvinists rest their faith upon the plain words of scripture as read in our translation. If we might hazard our own opinion, we should say that the truth lies between them, and that it has been found by the moderate men of both parties, who, while they make use of different language, seem to us to have the same sentiments. That all mankind really sinned in Adam, and are on that account liable to most grievous torments in soul and body, without intermission, in hell fire for ever, is a doctrine which cannot be reconciled to our natural notions of God. On the other hand, if human nature was not somehow debased by the fall of our first parents, it is not easy to account for the numberless phrases in scripture which certainly seem to speak that language, or for the very general opinion of the Pagan philosophers and poets respecting the golden age and the degeneracy of man. Cicero, in a quotation preserved

129 The opinions of moderate men among the Calvinists and Arminians the same, and countenanced by general tradition.

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preserved by St Augustine from a work that is now lost has these remarkable words, "Homo non ut a matre sed ut a noverca natura editus est in vitam, corpore nudo, et fragili, et infirmo; animo autem anxio ad molestias, humili ad timores, molli ad labores, prono ad libidines; in *quo tamen inest tanquam obrutus quidam divinus ignis ingenii et mentis* ||." Nor do we readily perceive what should induce the more zealous Arminians to oppose so vehemently this general opinion of the corruption of human nature. Their desire to vindicate the justice and goodness of God does them honour; but the doctrine of inherent corruption militates not against these attributes; for what we have lost in the first Adam has been amply supplied to us in the second; and we know from the highest authority that the duties required of us are in proportion to our ability, since we are told, that "unto whomsoever much is given, of him shall much be required."

|| Vide *D. Aug.* lib. iv. *contra Pelagium.* Vide etiam *M. Tull. Cicer. Consol.*

Sect. IV. *View of Theology from the fall of Adam to the coming of Christ.*

We have dwelt long on the original state of man, his introduction into the terrestrial paradise, the privileges to which he was there admitted, his forfeiture of those privileges, and the state to which he was reduced by transgressing the law of his Maker; but the importance of these events renders them worthy of all the attention that we have paid to them. They paved the way for the coming of Christ and the preaching of the gospel, and unless we thoroughly understand the origin of the gospel, we cannot have an adequate conception of its design. By contrasting the first with the second Adam, St Paul gives us clearly to understand, that one purpose for which Christ came into the world and suffered death on the cross, was to restore to mankind that life which they had lost by the fall of their original progenitor. The preaching of the gospel therefore commenced with the first hint of such a restoration; and the promise given to Adam and Eve, that "the seed of the woman should bruise the head of the serpent," was as truly evangelical as these words of the apostle, by which we are taught, that "this is a faithful saying and worthy of all acceptation, that Christ Jesus came into the world to save sinners †." The former text taken by itself is indeed obscure, and the latter is explicit; but both belong to the same system, for the Scriptures contain but two covenants or dispensations of God to man, in which the whole race is included.

† 1 Tim. i. 15.

130
Christianity may be said to have commenced with the fall.

Christianity therefore is indeed very near as old as the creation; but its principles were at first obscurely revealed, and afterwards gradually developed under different forms as mankind became able to receive them, (see Prophecy, N° 5. &c.). All that appears to have been at first revealed to Adam and Eve was, that by some means or other one of their posterity should in time redeem the whole race from the curse of the fall; or if they had a distinct view of the means by which that redemption was to be wrought, it was probably communicated to them at the institution of sacrifices, (see Sacrifice). This promise of a future deliverer served to comfort them under their heavy sentence; and the institution of sacrifices, whilst it impressed upon their minds lively ideas of the punishment due to their transgression, was admirably calculated to prepare both them and their posterity for the great atonement which, in due time, was to take away the sins of the world.

131
Revelations frequent in the early ages of the world.

Our first parents, after their fall, were so far from being left to fabricate a mode of worship for themselves by those innate powers of the human mind of which we daily hear so much, and feel so little, that God was graciously pleased to manifest himself to their *senses*, and visibly to conduct them by the angel of his presence in all the rites and duties of religion. This is evident from the different discourses which he held with Cain, as well as from the complaint of that murderer of being hid from his face, and from its being said, that "he went out from the presence of the Lord and dwelt on the east of Eden." Nor does it appear that God wholly withdrew his visible presence, and left mankind to their own inventions, till their wickedness became so very great that his spirit could no longer strive with them. The infant state of the world stood in constant need of his supernatural guidance and protection. The early inhabitants of this globe cannot be supposed to have been able, with Moses ||, to look up to him who is *invisible*, and perform a worship purely rational and spiritual. They were all tillers of the ground, or keepers of cattle; employed in cultivating and replenishing this new world; and, through the curse brought upon it by their forefather, forced, with him, to eat their bread "in the sweat of their brow." Man in such circumstances could have little leisure for speculation; nor has mere speculation, unless furnished with principles from another source, ever generated in the human mind adequate notions of God's nature or providence, or of the means by which he can be acceptably worshipped. Frequent manifestations, therefore, of his presence would be necessary to keep a tolerable sense of religion among them, and secure obedience to the divine institutions; and that the Almighty did not exhibit such manifestations, cannot be inferred from the silence of that very short history which we have of those early ages. Adam himself continued 930 years a living monument of the justice and mercy of God; of his extreme hatred and abhorrence of sin, as well as of his love and long suffering towards the sinner. He was very sensible how sin had entered into the world, and he could not but apprise his children of its author. He would at the same time inform them of the unity of God, and his dominion over the evil one; of the means by which he had appointed himself to be worshipped; and of his promise of future deliverance from the curse of the fall. Such information would produce a tolerable idea of the Divine Being, and afford sufficient motives to obey his will. The effects of it accordingly were apparent in the righteous family of Seth, who soon distinguished themselves from the posterity of Cain, and for their eminent piety were honoured with the appellation of *the sons of God*. Of this family sprang a person so remarkable for virtue and devotion, as to be exempted from Adam's sentence and the common lot of his sons; for after he had walked with God 300 years, and prophesied to his brethren, he was translated that he should not see death. Of this miraculous event there can be no doubt but that his contemporaries had some visible demonstration; and as the fate of Abel was an argument to their reason, so the translation of Enoch was a proof to their senses of another state of life after the present. To Adam himself, if

|| Heb. xi. 23.

if he was then alive (s), it must have been a lively and affecting instance of what he might have enjoyed, had he kept his innocence: it must have been a comfortable earnest of the promised victory over the evil one; and have confirmed his hope, that when the head of the serpent should be completely bruised, he and his posterity would be restored to the favour of their Maker, and behold his presence in bliss and immortality.

132 yet vice, and probably idolatry, soon became prevalent.

Notwithstanding this watchful care of God over his fallen creature man, vice, and probably idolatry, spread through the world with a rapid pace. The family of Seth married into that of Cain, and adopted the manners of their new relations. Rapine and violence, unbounded lust and impurity of every kind, prevailed universally; and when those giants in wickedness had filled the earth with tyranny, injustice and oppression; when the whole race was become entirely carnal—God, after raising up another prophet to give them frequent warnings of their fate for the space of 120 years, was at length obliged, in mercy to themselves as well as to the succeeding generations of men, to cut them off by a general deluge. See DELUGE.

133 Pure religion for some time after the flood;

Thus did God, by the spirit of prophecy, by frequent manifestations of his own presence, and by uninterrupted tradition, make ample provision for the instruction and improvement of the world for the first 1600 years. After the deluge he was pleased to converse again with Noah, and make in his person a new and extensive covenant with mankind, (see PROPHECY, N° 11.). Of his power, justice, and goodness; of his supreme dominion over the earth and the heavens; of his abhorrence of sin, and his determination not to let it go unpunished—that patriarch and his family had been most awfully convinced: nor could they or their children, for some time, want any other argument to enforce obedience, fear, and worship. The sons of Noah were an hundred years old when the deluge overwhelmed the earth. They had long conversed with their ancestors of the old world, had frequented the religious assemblies, observed every Sabbath day, and had been instructed by those who had seen Adam. It is therefore impossible that they could be ignorant of the creation of the world, of the fall of man, or of the promise of future deliverance from the consequences of that fall; or that they could offer their sacrifices, and perform the other rites of the instituted worship, without looking forward with the eye of faith to that deliverance seen, perhaps obscurely, through their typical oblations.

134 Idolatry, however, the cause of the dispersion from Babel.

In this state of things religion might for some time be safely propagated by tradition. But when by degrees mankind corrupted that tradition in its most essential parts; when, instead of the one Supreme God, they set up several orders of inferior deities, and worshipped all the host of heaven; when, at the same time they were uniting under one head, and forming a universal empire under the patronage of the Sun their chief divinity (see BABEL)—God saw it necessary to disperse them into distinct colonies, by causing such discord among them as rendered it impossible for any one species of idolatry to be at once universally established.

After this dispersion, there is reason to believe that particular revelations were vouchsafed wherever men were disposed to regard them. Peleg had his name prophetically given him from the dispersion which was to happen in his days; and not only his father Eber, but all the heads of families mentioned from Noah to Abraham, are with much plausibility supposed to have had the spirit of prophecy on many occasions. Noah was undoubtedly both priest and prophet; and living till within two years of the birth of Abraham, or, according to others, till that patriarch was near 60 years old, he would surely be able to keep up a tolerable sense of true religion among such of his descendants as sojourned within the influence of his doctrine and example. His religious son Shem, who lived till after the birth of Isaac, could not but preserve in tolerable purity the faith and worship of the true God among such of his own descendants as lived in his neighbourhood.

But though the remains of true religion were thus preserved among a few righteous men, idolatry had in a short time prevailed so far among the sons of Noah, that God saw it expedient not only to shorten the lives of men, but also to withdraw his presence from the generality, who had thus rendered themselves unworthy of such communications; and to select a particular family, in which his worship might be preserved pure amidst the various corruptions that were overspreading the world.

135 The call of Abraham was

With this view Abraham was called, and, after many remarkable trials of his faith and constancy, admitted to a particular intimacy and friendship with his Maker. God entered into a peculiar covenant with him, engaging to be his present guide, protector, and defender; to bestow all temporal blessings upon him and his seed; and to make some of those seed the instruments of conveying blessings of a higher kind to all the nations of the earth.

136 to prevent the universal spreading of idolatry.

It was doubtless for his singular piety that Abraham was fixed upon to be the parent of that people, who should preserve the knowledge of the unity of God in the midst of an idolatrous and polytheistic world; but we are not to imagine that it was for his sake only that all this was done, or that his less worthy descendants were by the equal Lord of all treated with partial fondness for the virtues of their ancestor; it was for the benefit of mankind in general that he was called from his country, and from his father's house, that he might preserve the doctrine of the divine unity in his own family, and be an instrument in the hand of Providence (and a fit one he was) to convey the same faith to the nations around him. Accordingly, we find him distinguished among the neighbouring princes, and kings reproved for his sake; who being made acquainted with his prophetic character, desired his intercession with God. History tells us of his conversing on the subject of religion with the most learned Egyptians, who appear to have derived from him or some of his descendants the rite of circumcision, and to have been for a while stopt in their progress towards the last stage of that degrading idolatry which afterwards rendered their national worship the opprobrium of the whole earth, (see POLYTHEISM, N° 28.) We are informed that his name was held in the greatest veneration all over the East; that the Magians, Sabians, Persians,

(s) According to the Samaritan chronology, he was alive; according to the Hebrew, he had been dead 57 years.

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Persians, and Indians, all glory in him as the greatest reformer of their respective religions: and to us it appears extremely probable, that not only the Brachmans, but likewise the Hindoo god Brahma *, derive their names from the father of the faithful. As he was let into the various counsels of the Almighty, and taught to reason and reflect upon them; as he was fully apprised of the overthrow of Sodom and Gomorrah, with the particular circumstances of that miraculous event; and as he had frequent revelations of the promised Redeemer, whose day he longed earnestly to see, and seeing it was glad—there can be no doubt but that he and his family took care to propagate these important doctrines in every nation which they visited; for the only reason which we can conceive for his being made to wander from place to place was, that different people might be induced to inquire after his profession, his religion, and his hopes.

* See *Asiatic Researches* and *Newt. Chron.*

137
Occasional revelations given to other pious men.

But though the Supreme Being was pleased to manifest himself in a more frequent and familiar manner to Abraham, he by no means left the rest of the world without sufficient light. Lot professed the true religion in the midst of Sodom. In Canaan we meet with Melchizedeck, king and priest of the most high God, who blessed Abraham, and to whom that patriarch himself did homage. Abimelech king of Gerar receiving an admonition from the Lord, immediately paid a due regard to it; and the same sense of religion and virtue descended to his son. Laban and Bethuel acknowledged the Lord, and the former of them was even favoured with a vision. In Arabia, we find Job and his three friends, all men of high rank, entering into the deepest disquisitions in theology; agreeing about the unity, omnipotence, and spirituality of God; the justice of his providence, with other fundamental articles of true religion; and mentioning divine inspiration or revelation as a thing not uncommon in their age and country † (U). Balaam appears to have been a true prophet: and as he was unquestionably a man of bad morals, the natural inference is, that the gift of prophecy was then, as afterwards, bestowed on individuals, not for their own sakes, but for the sake of the public; and that, as in "every nation, he who feareth God and worketh righteousness is accepted of him;" so in those early ages of the world, when mankind were but children in religious knowledge, they were blessed with the light of divine revelation wherever they were disposed to make a proper use of it.

† Job iv. 12, 15, 16, 17. vi. 10. xxiii. 12.

138
A second purpose for which Abraham was called.

Very few, however, appear to have had this disposition; and therefore God was pleased to adopt Abraham and part of his posterity as the race from which the great Redeemer was to spring, to train them up by degrees in suitable notions of their Creator, and gradually to open up to them, as they were able to receive it, the nature of that dispensation under which "all the nations of the earth were to be blessed in the patriarch's seed, (see PROPHECY, N° 13.). For this purpose, he held frequent correspondence with them; and to strengthen and confirm their faith, to fix and preserve their dependence on the one God of heaven and earth, he daily gave them new promises, each more magnificent than that which preceded it. He blessed Isaac, miraculously increased his substance, and soon made him the envy of the neighbouring princes. He foretold the condition of his two sons, renewed the promise made to Abraham, and blessed the adopted son Jacob, with whom he condescended to converse as he had conversed with Abraham and Isaac; renewing to him the great promise; bestowing upon him all kinds of riches; and impressing such terror upon all the cities which were round about him as prevented them from hurting either him or his family.

All this was indeed little enough to keep alive even in the mind of Jacob a tolerable sense of duty and dependence on his Creator. After the first vision he is surprised, and hesitates, seemingly inclined to make a kind of stipulation with his Maker, "If (says he) God will be with me, and will keep me in this way that I go, and will give me bread to eat, and raiment to put on, so that I come again to my father's house in peace, *then* shall the Lord be my God †." It appears not to have been till after many such revelations, blessings, and deliverances, and being reminded of the vow which on this occasion he had vowed, that he set himself in good earnest to reform the religion of his own family, and to drive out from it all strange gods *. So little able, in that age, were the boasted powers of the human mind to preserve in the world just notions of the unity of the Godhead, that we see there was a necessity for very frequent revelations, to prevent even the best men from running headlong into polytheism and idolatry.

† Gen. xxviii. 20. 21.

* Gen. xxxv. 2.

Thus was God obliged to treat even with the patriarchs themselves, by way of positive covenant and express compact; to promise to be their God if they would be his people; to give them a portion of temporal blessings as introductory to future and spiritual ones; and to engage them in his service by immediate rewards, till they could be led on to higher views, and prepared by the bringing in of a better hope to worship him in spirit and in truth. With regard to what may be called the *theory* of religion, mankind were yet scarcely got out of their childhood. Some extraordinary persons indeed occasionally appeared in different countries, such as Enoch, Noah, Abraham, and Job, with many others, who had a more enlarged prospect of things, and entertained more worthy sentiments of the divine dispensations and of the ultimate end of man; but these were far superior to the times in which they lived, and appear to have been providentially raised up to prevent the savage state and savage idolatry from becoming universal among men. See SAVAGE.

139
The patriarchal worship of those early ages performed in faith.

The worship which was practised by those holy men appears to have consisted principally of the three kinds of sacrifice mentioned elsewhere (see SACRIFICE); to which were doubtless added prayers and praises, with the

(U) There are great disputes among the learned respecting the antiquity and the author of the *book* of Job, and whether it be a history of events, or a poem which has its foundation in history. All sober men, however, are agreed, that there really was such a *person* as Job, eminent for patience under uncommon sufferings; and that he was of very remote antiquity. The LXX give us the names of his father and mother, and say that he was the fifth from Abraham.

the more valuable oblation of pure hands and devout hearts. Such of them as looked forward to a future redemption, and had any tolerable notion of the means by which it was to be effected, as Abraham certainly had, must have been sensible that the blood of bulls and of goats could never take away sin, and that their sacrifices were therefore valuable only when they were offered in faith of that great promise, "which they, having seen it afar off, were persuaded of, and embraced: and confessed that they were strangers and pilgrims upon earth."

That such persons looked for "a better country, even a heavenly one," in a future state, cannot be questioned; for they knew well how sin and death had entered into the world, and they must have understood the promise made to their original progenitor, and repeatedly renewed to themselves, to include in it a deliverance at some period from every consequence of the first transgression. They were to all intents and purposes Christians as well as we.

140 Of a future Redeemer.

They indeed placed their confidence in a Redeemer, who in the fulness of time was to appear upon earth, while we place ours in a Redeemer that has been already manifested; they expressed that confidence by one mode of worship, we express it by another; but the patriarchal worship had the same end in view with the Christian—the attainment of everlasting life in heaven.

141 Such faith, however, not general.

The generality of men, however, appear not, in the early age of which we now write, to have extended their views beyond the present life. From the confused remains of ancient tradition, they acknowledged indeed some superior power or powers, to whom they frequently applied for direction in their affairs; but in all probability it was only for direction in temporal affairs, such as the cultivation of the ground, or their transactions with each other. In the then state of things, when no part of the world was overstocked with inhabitants, and when luxury with its consequences was everywhere unknown, virtue and vice must have produced their natural effects; and the good man being happy here, and the wicked man miserable, reason had no data from which to infer the reality of a future state of rewards and punishments. Those who were blessed with the light of revelation undoubtedly looked forward to that state with a holy joy; but the rest worshipped superior powers from worldly motives. How many of those powers there might be, or how far their influence might reach, they knew not. Uncertain whether there be one Supreme Governor of the whole world, or many co-ordinate powers presiding each over a particular country, climate, or place—gods of the hills and of the valleys, as they were afterwards distinguished—they thought that the more of these they could engage in their interest the better. Like the Samaritans therefore, in after times, they sought, wherever they came, the "the manners of the god of the land," and served him, together with their own gods.

142 The purpose for which the Israelites were made to sojourn in Egypt.

Thus was the world ready to lose all knowledge of the true God and his worship, had not he been graciously pleased to interpose, and take effectual care to preserve that knowledge in one nation, from which it might be conveyed to the rest of mankind at different times, and in greater or less degrees, as they should be capable of receiving it. To this purpose he made way for the removal of Jacob and his family to one of the most improved and polished countries of the world; and introduced them into it in a manner so advantageous, as to give them an opportunity of imparting much religious knowledge to the natives. The natives, however, were gross idolaters; and that his chosen people might be as far as possible from the contagion of their example, he placed them upon the borders of Egypt, where, though they multiplied exceedingly, they were by their very occupation * still kept a separate people, and must have been rendered, by a long and severe oppression, in a great degree averse to the manners and religion of their neighbours. This aversion, however, seems to have gradually become less and less; and before they were miraculously redeemed from their house of bondage, they had certainly lost all correct notions of the unity of God, and the nature of his worship, and had adopted the greater part of the superstitions of their task-masters. Of this we need no other proof than what is implied in the words of Moses ‡, when he said unto God, "Behold, when I come unto the children of Israel, and say

143 Consequences of it.

unto them, the God of your fathers hath sent me unto you; and they shall say unto me, WHAT IS HIS NAME? what shall I say unto them?" Had not the destined lawgiver of the Hebrews been aware that his countrymen had adopted a plurality of gods, this difficulty could not have occurred to him; for *names* are never thought of but to distinguish from each other beings of the same kind; and he must have remembered, that in Egypt, where the multitude of goods was marshalled into various classes, the knowledge of their names was deemed of great importance. This we learn likewise from Herodotus, who informs us §, that the Pelasgi, after settling in Greece, thought it necessary to consult the oracle of Dodona, whether it would be proper to give to their own gods the names of the Egyptian divinities? and that the oracle, as might have been supposed, assured them that it would. Indeed the Hebrews during their residence in Egypt had acquired such an attachment to the idolatrous worship of the country, that it appears never to have left them entirely till many ages afterwards, when they were carried captive into Babylon, and severely punished for their repeated apostasies; and so completely were they infatuated by these superstitions at the era of their exodus, that, as the prophet Ezekiel informs us ||, they rebelled against God, and would not cast away their abominations, or forsake the idols of Egypt, even in the *very day* that the hand of Omnipotence was lifted up to bring them forth of that land in which they had been so long and so cruelly oppressed. In such a state of things, to have suffered them to remain longer in Egypt, could have served no good purpose; and therefore to fulfil the promise which he had given to Abraham, God determined to deliver them out of the hands of the Egyptians by means which should convince both them and their offspring of his own supremacy over heaven and earth.

144 Moses appointed to bring them out of Egypt.

As Moses was the person appointed to deliver God's message to Pharaoh, and to demand of him leave for the Israelites to go three days journey into the wilderness to serve the God of their fathers, it was necessary that he should be endowed with the power of working miracles to evince the reality of his divine mission. Without a conviction that his claims were well founded, neither Pharaoh nor his own countrymen could reasonably have been expected to listen to the proposals of a man who, though blessed in his youth with a princely education, had come directly on his embassy from the humble employment

* Gen. xlvi. 33, 34.

‡ Exod. iii. 13

§ Lib. ii. cap. 52, 53.

|| Ch. xx.

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ployment of a shepherd, which he had for many years exercised in the country of Midian. To prove that he was really sent by God, any visible and undoubted controul of the laws of nature would have been abundantly sufficient; but he was to prove not only this truth, but also the unity of the Divine nature; and the miracles which he was directed to work were executions of judgement against the very gods of Egypt †.

† Exod. xii. 12.

145 The propriety of the miracles which he wrought

When Pharaoh first turned a deaf ear to his request, though enforced by the conversion of a rod into a serpent, at the command of Jehovah he smote with the same rod upon the waters in the river, which were instantly converted into blood, and occasioned the death of all the fishes that swam in them. To any people this miracle would have been a proof of Divine agency: but it was in a particular manner calculated to open the eyes of the blind and infatuated Egyptians, who considered the Nile as one of their greatest gods, and all the fishes that it contained as subordinate divinities. They called that noble river sometimes *Sirius*, sometimes *Osiris*, sometimes *Canobus* (see CANOBUS), and not unfrequently Ωκεαμης (x); and adored it as the parent of all their deities. What then must the people have thought when they found their most revered god, at the command of a servant of Jehovah, converted into blood, and all his sacred offspring into stinking carcases? To conceive their consternation, if it can be conceived, the reader must remember, that the Egyptian priests held blood in the utmost abhorrence, as a thing of which the very touch would deeply pollute them, and require immediate and solemn expiation. The same sacred river was a second time polluted, when it sent forth frogs, which covered all the land of Egypt, and died in the houses, in the villages, and in the fields; thus rendering it impossible for the people to avoid the touch of dead bodies, though from every such contact they believed themselves to contract an impurity, which, in the case before us, must have been the more grievous, that in the whole country there was not left a pool of uninfected water to wash away the stain.

146 to evidence the vanity of idol worship.

The third plague inflicted on the Egyptians was, the converting of the dust of the land into lice, upon man and upon beast, throughout the whole kingdom. To see the propriety of this miracle as a judgment upon their idolatry, we must recollect their utter abhorrence of all kinds of vermin, and their extreme attention to external purity above every other people perhaps that has hitherto existed on the face of the earth. On this head they were more particularly solicitous when about to enter the temples of their gods; for Herodotus informs us, that their priests wore linen raiment only, and shaved off every hair from their heads and bodies, that there might be no *louse* or other detestable object upon them when performing their duty to the gods. This plague therefore, while it lasted, made it impossible for them to perform their idolatrous worship, without giving such offence to their deities as they imagined could never be forgiven. Hence we find, that on the production of the lice, the priests and magicians perceived immediately from what hand the miracle had come, and exclaimed, "This is the finger of God!" The fourth plague seems to have been likewise acknowledged to be the finger of God, if not by the magicians, at least by Pharaoh; for in a fit of terror he agreed that the Israelites should go and serve the Lord. That he was terrified at the swarms of flies which infested the whole country, except the land of Goshen, will excite no wonder, when it is known that the worship of the fly originated in Egypt; whence it was carried by the Caphtorim to Palestine; by the Phœnicians to Sidon, Tyre, and Babylon; and from these regions to other parts of the world. The denunciation of this plague was delivered to Pharaoh early in the morning, when he was on the banks of the Nile, probably paying his accustomed devotion to his greatest god; and when he found himself and his people tormented by a swarm of subordinate divinities, who executed the judgment of Jehovah in defiance of the power of the supreme *numen* of Egypt, he must have been convinced, had any candour remained in his mind, that the whole system of his superstition was a mass of absurdities, and that his gods were only humble instruments at the disposal of a Superior Power. He was not, however, convinced; he was only alarmed, and quickly relapsed into his wonted obstinacy. The fifth plague therefore, the murrain among the cattle, brought death and destruction on his most revered gods themselves. Neither Osiris, nor Isis, nor Ammon, nor Pan, had power to save his brute representatives. The sacred bull, and heifer, and ram, and goat, were carried off by the same malady which swept away all the other herds of deities, these *dii stercorei*, who lived on grass and hay. The impression of this punishment must have been awful on the minds of the Egyptians, but perhaps not equal to that which succeeded it.

In Egypt there were several altars on which human sacrifices were offered; and from the description of the persons qualified to be victims, it appears that those unhappy beings must have been foreigners, as they were required to have bright hair and a particular complexion. The hair of the Israelites was much brighter than that of the Egyptians, and their complexions fairer; and therefore there can be little doubt but that, during their residence in Egypt, they were made to furnish the victims demanded by the bloody gods. These victims being burnt alive on a high altar, and thus sacrificed for the good of the nation, their ashes were gathered together by the priest, and scattered upwards in the air, that a blessing might be entailed on every place to which an atom of this dust should be wafted. Moses too, by the direction of the true God, took ashes of the furnace, probably of one of those very furnaces in which some of his countrymen had been burnt, and sprinkling them towards heaven in the sight of Pharaoh, brought boils and blains upon all the people, of so malignant a nature, that the magicians and the other ministers of the medical gods, with which Egypt abounded beyond all other countries, could not themselves escape the infection.

The powers of darkness were thus foiled; but the heart of the monarch was still hardened. Destruction was therefore next brought on him and his country by the elements, which were among the earliest idol deities not

(x) Whence came the Greek word ωκεανος, *the ocean*.

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not only of the Egyptians, but of every other polytheistic nation. "The Lord rained hail on the land of Egypt; so that there was hail, and fire mingled with the hail, such as there was none like it in all the land of Egypt since it became a nation. And the hail smote throughout all the land of Egypt all that was in the field, both man and beast; and the hail smote every herb of the field, and broke every tree of the field." This was a dreadful calamity in itself; and the horror which it excited in the minds of the people must have been greatly aggravated by the well-known fact, that Egypt is blessed with a sky uncommonly serene; that in the greatest part of it rain has never been seen at any other time since the creation of the world; and that a slight and transient shower is the utmost that in the ordinary course of nature falls anywhere throughout the country. The small quantity of vegetables which was left undestroyed by the fire and the hail was afterwards devoured by locusts, which by a strong east wind were brought in such numbers from Arabia, where they abounded at all times, that they covered the whole face of the earth, and did eat every herb of the land, and all the fruit of the trees, so that there remained not any green thing in the trees or in the herbs of the field through all the land of Egypt.

The ninth plague which the obstinacy of Pharaoh brought upon his country, whilst it severely punished the Egyptians for their cruelty to the Hebrews, struck at the very foundation of all idolatry. We have elsewhere shown, that the first objects of idolatrous worship were the contending powers of light and darkness (see POLYTHEISM); and that the benevolent principle, or the power of light, was everywhere believed to maintain a constant superiority over the power of darkness. Such was the faith of the ancient Persians; and such, as a very learned writer has lately proved, was likewise the faith of the earlier Egyptians. It was therefore with wisdom truly divine, that God, to show the vanity of their imaginations, brought upon these votaries of light, who fancied themselves the offspring of the sun, a preternatural darkness, which, for three days, all the powers of their supreme deity, and his subordinate agents, could not dispel.

The tenth and last plague brought on this idolatrous people was more universally and severely felt than any which had preceded it. It was likewise, in some sense, an instance of the *lex talionis*, which requires an eye for an eye, and a tooth for a tooth, &c. Moses was commanded, at his first interview with Pharaoh, to say, "Thus saith the Lord, Israel is my son, even my first-born. Let my son go that he may serve me: and if thou refuse to let him go, behold, I will slay thy son, even thy first-born." Before this threat was put in execution, every attempt was made to soften the hardened heart of the obstinate tyrant. The waters of his sacred river were turned into blood, and all the fishes that it contained slain; frogs were brought over all the land to pollute the people; the ministers of religion were rendered so impure by vermin, that they could not discharge their wonted offices; the animals most revered as gods, or emblems of gods, were cut off by a murrain; the elements, that were everywhere worshipped as divinities, carried through the land a devastation, which was completed by swarms of locusts; the ashes from the sacred furnace, which were thought to convey blessings whithersoever they were wafted, were made to communicate incurable disease; a thick and preternatural darkness was spread over the kingdom, in defiance of the power of the great Osiris; and when the hearts of the people and their sovereign continued still obdurate, the eldest son in each family was slain, because they refused to let go Israel, God's first-born. From this universal pestilence the Israelites were preserved by sprinkling the door-posts of their houses with the blood of one of the animals adored in Egypt; a fact which, as it could not be unknown to Pharaoh or his subjects, ought to have convinced that people of the extreme absurdity of their impious superstitions. This effect it seems not to have had; but the death of the first-born produced the deliverance of the Hebrews; for when it was found that there was not a house where there was not one dead, "Pharaoh called for Moses and Aaron by night, and said, Rise up, and get you forth from among my people, both you and the children of Israel; and bless me also. And the Egyptians were urgent upon the people, that they might send them out of the land in haste; for they said, We be all dead men (Y)." The wonted obstinacy of the monarch indeed very soon returned; and his subjects, forgetting the loss of their children, joined with him in a vain attempt to bring back to bondage the very people whom they had been thus urgent to send out of the land; but their attempt was defeated by Jehovah, and all who engaged in it drowned in the Red sea.

147 Reason of detaining the Israelites so long in the wilderness.

The God of Israel having thus magnified himself over the Egyptians and their gods, and rescued his people from bondage by such means as must not only have struck terror and astonishment into the whole land, but also have spread his name through all the countries which had any communication with that far-famed nation, proceeded to instruct and exercise the Hebrews for many years in the wilderness. He inculcated upon them the unity of the Godhead; gave them statutes and judgments more righteous than those of any other nation; and by every method consistent with the freedom of moral agency guarded them against the contagion of idolatry and polytheism. He sent his angel before them to keep them in the way, took upon himself the office of their supreme civil governor, and by his presence directed them in all their undertakings. He led them with repeated signs and wonders through the neighbouring nations, continued to try and discipline them

(Y) For this account of the plagues of Egypt, we are indebted to the very valuable *Observations* on the subject published by *Mr Bryant*. We have not quoted the authorities by which the learned and pious author supports his opinions; because it is to be hoped, that for a fuller account of these important transactions the reader will have recourse to his work, of which we have given only a very brief abstract. For much of the preceding parts of this section, we acknowledge our obligations to Bishop Law's admirable discourse on the *Several Dispensations of Revealed Religion.*

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them till they were tolerably attached to his government and established in his worship, and introduced them into the Promised Land when its inhabitants were ripe for destruction. At their entrance into it, he gave them a summary repetition of their former laws, with more such ordinances, both of a ceremonial and moral kind, as were both suited to their temper and circumstances, as well as to prefigure, and by degrees to prepare them for, a more perfect dispensation under the Messiah.

148
Great objects of the Jewish law.

The Jewish law had two great objects in view; of which the first was to preserve among them the knowledge of the true God, a rational worship springing from that knowledge, and the regular practice of moral virtue: and the second was to fit them for receiving the accomplishment of the great promise made to their ancestors, by means analogous to those which a schoolmaster employs to fit his pupils for discharging the duties of maturer years. Every thing in that law peculiar to itself, its various ceremonies, modes of sacrificing, the sanctions by which it was enforced, and the theocratic government by which it was administered, had a direct tendency to promote one or other of these ends; and keeping these ends in view, even the minutest laws, at which impious ignorance has affected to make itself merry, will be discovered by those who shall study the whole system, and are at the same time acquainted with the genius of ancient polytheism, to have been enacted with the most consummate wisdom.

It is not easy for us, who have been long blessed with the light of revelation, to conceive the propensity of all nations, in that early age of the world, to the worship of false gods, of which they were daily adding to the number. It is indeed probable, from many passages of Scripture, as well as from profane authors of the greatest antiquity, that one supreme *numen* was everywhere acknowledged: but he was considered as an extramundane being, too highly exalted to concern himself with the affairs of this world, the government of which, it was believed, he had delegated to various orders of subordinate deities. Of those deities, some were supposed to have the charge of one nation and some of another. Hence it is, that we read of the gods of Egypt, the gods of the Amorites, and the gods of the different nations around Palestine. None of those nations denied the existence of their neighbour's gods; but all agreed, that while the Egyptians were the peculiar care of Osiris and Isis, the Amorites might be the favourites of Moloch, the Phœnicians of Cronus, and the Philistines of Dagon; and they had no objection occasionally to join with each other in the worship of their respective tutelary deities. Nay, it was thought impiety in foreigners, while they sojourned in a strange country, not to sacrifice to the gods of the place. Thus Sophocles makes Antigone say to her father, that a stranger should both venerate and abhor those things which are venerated and abhorred in the city where he resides; and another author *, who, though comparatively late, drew much of his information from ancient writings which are now lost, assures us, that this complaisance proceeded from the belief that the "several parts of the world were from the beginning distributed to several powers, of which each had his peculiar allotment and residence."

* *Celsus apud Aug.*

From this notion of local divinities, whose power or partial fondness was confined to one people, the Israelites, on their departure from Egypt, appear not to have been free (z). Hence it is, that when the true God first tells them, by their leader Moses †, that if they would obey his voice indeed and keep his covenant, then they should be a PECULIAR TREASURE to him above all people: to prevent them from supposing that he shared the earth with the idols of the heathen, and had from partial fondness chosen them for his *portion*, he immediately adds, for ALL THE EARTH IS MINE. By this addition he gave them plainly to understand that they were chosen to be his peculiar treasure for some purpose of general importance; and the very first article of the covenant which they were to keep was, that they should have no other gods but him. So inveterate, however, was the principle which led to an intercommunity of the objects of worship, that they could not have kept this article of the covenant but in a state of separation from the rest of mankind ‡; and that separation could neither have been effected nor continued without the visible providence of the Almighty watching over them as his peculiar treasure. This we learn from Moses himself, who, when interceding for the people after their idolatrous worship of the golden calf, and intreating that the presence of God would still accompany them, adds these words §: "For wherein shall it be known here that I and thy people have found grace in thy sight? Is it not in that THOU GOEST WITH US? So shall we be SEPARATED, I and thy people, from all the people that are on the face of the earth." On this separation every thing depended; and therefore to render it the more secure, Jehovah was graciously pleased to become likewise their supreme Magistrate, making them a "kingdom of priests and a holy nation," and delivering to them a digest as well of their civil as of their religious laws.

† Exod. xix. 5.

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Purpose of their separation from other people.

‡ 1 Sam. xxvi. 19.

§ Exod. xxxiii. 16.

150
Of their theocratic government,

The Almighty thus becoming their King, the government of the Israelites was properly a THEOCRACY, in which the two societies, civil and religious, were of course incorporated. They had indeed after their settlement in the Promised Land, at first, temporary *judges* occasionally raised up; and afterwards permanent magistrates called *kings*, to lead their armies in war, and to give vigour to the administration of justice in peace: but neither those judges nor those kings could abrogate a single law of the original code, or make the smallest addition to it but by the spirit of prophecy. They cannot

(z) It is not indeed evident that they had got entirely quit of this absurd opinion at a much later period. Jephtha one of their judges, who, though half paganized (as Warburton observes) by a bad education, had probably as correct notions of religion as an ordinary Israelite, certainly talked to the king of Ammon as if he had believed the different nations of the earth to be under the immediate protection of different deities: "Wilt not thou (says he) possess that which Chemosh THY GOD giveth thee to possess! So whomsoever the Lord OUR GOD shall drive out from before us, them will we possess." (Judges xi. 24.).

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not therefore be considered as supreme magistrates, by whatever title they may have been known; for they were to go out and come in at the word of the priests, who were to ask counsel for them of the Lord, and with whom they were even associated in all judicial proceedings, as well of a civil as of a spiritual nature *. Under any other than a theocratic government, the Hebrews could not have been kept separate from the nations around them; or if they could, that separation would not have answered the great purpose for which it was established. "The people, on their leaving Egypt, were sunk into the lowest practices of idolatry. To recover them by the discipline of a separation, it was necessary that the idea of God and his attributes should be impressed upon them in the most *sensible* manner. But this could not be commodiously done under his character of God of the universe: under his character of King of Israel, it well might. Hence it is, that we find him in the Old Testament so frequently represented with affections analogous to human passions. The civil relation in which he stood to the Israelites made such a representation natural; the grossness of their conceptions made the representation necessary; and the guarded manner in which it was always qualified prevented it from being mischievous †." Hence too it is, that under the Mosaic dispensation, idolatry was a crime of state, punishable by the civil magistrate. It was indeed high treason, against which laws were enacted on the justest principles, and carried into effect without danger of error. Nothing less indeed than penal laws of the severest kind could have restrained the violent propensity of that headstrong people to worship, together with their own God, the gods of the Heathen. But penal laws enacted by human authority for errors in religion are manifestly unjust; and therefore a theocratic government seems to have been absolutely necessary to obtain the end for which the Israelites were separated from the surrounding nations.

* Num. xxvii. 21. and Deut. xvii. 8—13.

† *Warburton's Div. Leg.* book v. sect. 2.

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and of the ritual law,

It was for the same purpose that the ritual law was given, after their presumptuous rebellions in the wilderness. Before the business of the golden calf, and their frequent attempts to return into Egypt, it seems not to have been the Divine intention to lay on them a yoke of ordinances; but to make his covenant depend entirely on their duly practising the rite of circumcision; observing the festivals instituted in commemoration of their deliverance from bondage, and other signal services vouchsafed them; and keeping inviolate all the precepts of the decalogue (A), which, if they had done, they should have even lived in them ‡. But after their repeated apostasies, and impious wishes to mix with the surrounding nations, it was necessary to subject them to a multifarious ritual, of which the ceremonial parts were solemn and splendid, fitted to engage and fix the attention of a people whose hearts were gross; to inspire them with reverence, and to withdraw their affections from the pageantry of those idle superstitions which they had so long witnessed in the land of Egypt. To keep them warmly attached to their public worship, that worship was loaded with operose and magnificent rites, and so completely incorporated with their civil polity as to make the same things at once duties of religion and acts of state. The service of God was indeed so ordered as to be the constant business as well as entertainment of their lives, supplying the place of all other entertainments; and the sacrifices which they were commanded to offer on the most solemn occasions, were of such animals as the Egyptians and other Heathens deemed sacred.

‡ *Divine Leg.* book iv. sect. 6.

152
instanced in their sacrifices,

Thus a heifer without blemish was in Egypt held sacred to the goddess Isis, and worshipped as the representative of that divinity; but the same kind of heifer was by the ritual law of the Hebrews commanded to be burnt without the camp, as the vilest animal, and the water of separation to be prepared from her ashes *. The goat was by the Egyptians held in great veneration as emblematical of their ancient god Pan, and sacrifices of the most abominable kind were offered to the impure animal (see PAN); but God, by his servant Moses, enjoined the Israelites to offer goats themselves as sacrifices for sin, and on one occasion to dismiss the live animal loaded with maledictions into the wilderness †. The Egyptians, with singular zeal, worshipped a calf without blemish as the symbol of Apis, or the god of fertility; and it appears from the book of Exodus, that the Israelites themselves had been infected with that superstition. They were, however, so far from being permitted by their Divine lawgiver to consider that animal as sacred, that their priests were commanded to offer for themselves a young calf as a sin-offering ‡. No animal was in Egypt held in greater veneration than the ram, the symbol of their god Ammon, one of the constellations. It was therefore with wisdom truly divine, that Jehovah, at the institution of the passover, ordered his people to kill and eat a young ram on the very day that the Egyptians began their annual solemnities § in honour of that animal as one of their greatest gods; and that he enjoined the blood of this divinity to be sprinkled as a sign on the two side-posts and upper door-post of the house in which he was eaten. Surely it is not in the power of imagination to conceive a ritual better calculated to cure the Israelites of their propensity to idol worship, or to keep them separate from the people who had first given them that propensity, than one which enjoined them to offer in sacrifice the very creatures which their superstitious masters had worshipped as gods. "Shall we (said Moses) sacrifice the abominations of the Egyptians before their eyes, and will they not stone us?"

* Num. xix.

† Levit. xvi.

‡ Levit. ix.

§ *Spencer de Legibus, Heb. Rit.* lib. ii. cap. iv.

But it was not against Egyptian idolatry only that the ritual law was framed: the nations of Syria, in the midst of whom the Israelites were to dwell, were addicted to many cruel and absurd superstitions, against which it was as necessary to guard the people of God as against the brute-worship of Egypt. We need not inform any reader of the book of Moses that those nations worshipped

(A) Of these precepts we think it not necessary, in an abstract so short as this, to waste the reader's time with a formal and laboured defence. To the decalogue no objection can be made by any man who admits the obligations of natural religion; for, except the observation of the Sabbath-day, it enjoins not a single duty which does not by the confession of all men result from our relations to God, ourselves, and our fellow-creatures.

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ped the sun and moon and all the host of heaven; or that it was part of their religion to propitiate their offended gods by occasionally sacrificing their sons and their daughters. From such worship and sacrifices the Israelites were prohibited under the severest penalties; but we cannot consider that prohibition as making part of the *ritual* law, since it relates to practices impious and immoral in themselves, and therefore declared to be abominations to the Lord. The Phœnicians, however, and the Canaanites, entertained an opinion that every child came into the world with a *polluted nature*, and that this pollution could be removed only by a *lustral fire*. Hence they took their new-born infants, and with particular ceremonies made them pass through the flame of a pile sacred to Baal or Moloch, the symbols of their great god the sun. Sometimes this purgation was delayed till the children had arrived at their tenth or twelfth year, when they were made either to leap through the flame, or run several times backwards and forwards between two contiguous sacred fires; and this lustration was supposed to free them from every natural pollution, and to make them through life the peculiar care of the deity in whose honour it was performed *. The true God, however, who would have no fellowship with idols, forbade all such purgations among his people, whether done by fires consecrated to himself or to the bloody deities of the Syrian nations. "There shall not be found (says he) among you any one that maketh his son or his daughter to pass through the fire †."

153 and in the laws respecting eating and drinking, and agriculture.

* *Spencer*, lib. ii. cap. 13.

† Deut. xvii. 10. xii. 29. and Levit. xx. 2, &c.

There are, in the Jewish law, few precepts more frequently repeated than that which prohibits the seething of a kid in his mother's milk ‡; and there being no moral fitness in this precept when considered absolutely and without regard to the circumstances under which it was given, infidel ignorance has frequently thought fit to make it the subject of profane ridicule. But the ridicule will be forborne by those who know that, among the nations round Judea, the feasting on a kid boiled in its mother's milk was an essential part of the impious and magical ceremonies celebrated in honour of one of their gods, who was supposed to have been suckled by a she-goat. Hence, in the Samaritan Pentateuch, the text runs thus: "Thou shalt not seeth a kid in its mother's milk; for whoever does so, is as one who sacrifices an abominable thing, which offends the God of Jacob §." Another precept, apparently of very little importance, is given in these words: "Ye shall not round the corners of your heads, neither shalt thou mar the corners of thy beard ||." But its wisdom is seen at once, when we know that at funerals it was the practice of many of the heathens, in that early period, to round the corners of their heads, and mar their beards, that by throwing the hairs they had cut off on the dead body, or the funeral pile, they might propitiate the shade of the departed hero; and that in other nations, particularly in Phœnicia, it was customary to cut off all the hair of their heads except what grew on the crown, which, with great solemnity, was consecrated either to the sun or to Saturn *. The unlearned Christian, if he be a man of reflection, must read with some degree of wonder such laws as these: "Thou shalt not sow thy vineyard with divers seeds, lest the fruit of thy seed which thou hast sown and the fruits of thy vineyard be defiled. Thou shalt not plough with an ox and an ass together. Thou shalt not wear a garment of divers sorts, or of woollen and linen together †." But his wonder will cease when he knows that all these were practices from which the Sabian idolaters of the east expected the greatest advantages. Their belief in magic and judicial astrology led them to imagine, that by sowing different kinds of corn among their vines they should propitiate the gods which were afterwards known in Rome by the names of Bacchus and Ceres; that, by yoking animals so heterogeneous as the ox and the ass in the same plough, they should by a charm secure the favour of the deities who presided over the affairs of husbandry; and that a garment composed of linen and woollen, worn under certain conjunctions of the stars, would protect its owner, his flocks, his herds, and his field, from all malign influences, and render him in the highest degree prosperous through the whole course of his life ‡. But magical ceremonies were always performed in order to render propitious good or evil demons (see MAGIC); and therefore such ceremonies, however unimportant in themselves, were in that age most wisely prohibited in the Mosaic law, as they naturally led those who were addicted to them to the worship of idols and impure spirits.

‡ Exod. xiii. 19. xxxiv. 26. Deut. xiv. 21.

§ *Spencer*, lib. ii. cap. 9.

|| Levit. xix. 27.

* *Spencer*, lib. ii. cap. 18.

† Deut. xxii. 9, 10, 11.

‡ *Spencer*, lib. ii. cap. 30, 31, 33.

If the whole ritual of the Jewish economy be examined in this manner, every precept in it will be found to be directed against some idolatrous practice of the age in which it was given. It was therefore admirably calculated to keep the Israelites a separate people, and to prevent too close an intercourse between them and their Gentile neighbours. The distinction made by their law between clean and unclean animals (see SLAVERY, N° 33.) rendered it impossible for them, without a breach of that law, to eat and drink with their idolatrous neighbours; their sacred and civil ceremonies being directly levelled against the Egyptian, Zabian, and Canaanitish superstitions, had a tendency to generate in their minds a contempt of those superstitions; and that contempt must have been greatly increased by their yearly, monthly, and daily sacrifices, of the very animals which their Egyptian masters had worshipped as gods.

154 The Mosaic laws enforced by temporal sanctions.

That these laws might have the fuller effect on minds gross and carnal, they were all enforced by temporal sanctions. Hence it is that Moses assured them that if they would hearken to God's judgments, and keep them, and do them, they should be blessed above all people; threatening them at the same time with utter destruction if they should at all walk after other gods, and serve them, and worship them §. Nor were these temporal rewards and punishments held out only to the nation as a collective body; they were promised and threatened to every individual in his private capacity as the certain consequences of his obedience or disobedience. Every particular Hebrew was commanded to honour his father and mother, that it might go well with him, and that his days might be prolonged; whilst he who cursed his father or his mother was surely to be put to death. Against every idolater, and even against the wilful transgressor of the ceremonial law, God repeatedly declared that he would set his face, and would cut off that man from among his people: and that individuals, as well as the nation, were in this life actually rewarded and punished according to their deserts, has been proved by Bishop Warburton ||. Indeed the Mosaic

§ Deut. *passim*.

|| *Div. Leg.* book. v. sect. 4.

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saic law, taken in its literal sense, holds out no other prospects to the Israelites than temporal happiness; such as health, long life, peace, plenty, and dominion, if they should keep the covenant; and temporal misery, viz. diseases, immature death, war, famine, want, subjection, and captivity, if they should break it. "See (says Moses), I have set before thee this day life and good, death and evil; in that I command thee this day to love the Lord thy God, to walk in his ways, and to keep his commandments, and his statutes, and his judgements, that thou mayest live and multiply; and the Lord thy God shall bless thee in the land whither thou goest to possess it. But if thine heart turn away, so that thou wilt not hear, but shalt be drawn away, and worship other gods, and serve them; I denounce unto you this day, that ye shall surely perish, and that ye shall not prolong your days upon the land whither thou passest over Jordan to possess it." And elsewhere, having informed them that, upon their apostasy, their land should be rendered like Sodom and Gomorrah, he adds, that all men should know the reason of such barrenness being brought upon it, and should say, "Because they have forsaken the covenant of the Lord God of their fathers, which he made with them when he brought them forth out of the land of Egypt, the anger of the Lord was kindled against this land, to bring upon it all the curses that are written in this book *."

* Deut. xxx. 15—19. xxxix. 25.

155 Whence it has been rashly inferred that the ancient Hebrews had no hope beyond the grave.

From this fact, which scarcely any man of letters will venture to deny, some divines have concluded, that the ancient Israelites had no hope whatever beyond the grave; and that in the whole Old Testament there is not a single intimation of a future state. That many of the lower classes, who could neither read nor write, were in this state of darkness, may be true; but it is impossible that those who understood the book of Genesis could be ignorant that death came into the world by the transgression of their first parents, and that God had repeatedly promised to redeem mankind from every consequence of that transgression. They must likewise have known that, before the deluge, Enoch was translated into heaven without tasting death; that afterwards Elijah had the same exemption from the common lot of humanity; and that, as God is no respecter of persons, every one who served him with the zeal and fidelity of these two prophets would, by some means or other, be made capable of enjoying the same rewards. The God of Abraham, Isaac, and Jacob, was not the God of the dead, but of the living.

In the earliest periods of their commonwealth, the Israelites could, indeed, only *infer*, from different passages of their sacred books, that there would be a general resurrection of the dead, and a future state of rewards and punishments; but from the writings of the prophets it appears, that before the Babylonish captivity that doctrine must have been very generally received. In the Psalms, and in the prophecies of Isaiah, Daniel, and Ezekiel, there are several texts which seem to us to prove incontrovertibly, that, at the time when these inspired books were written, every Israelite who could read the scriptures must have had some hopes of a resurrection from the dead. We shall consider two of these texts, because they have been quoted by a very learned and valuable writer in support of an opinion the reverse of ours.

In a sublime song, composed with a view to incite the people to confidence in God, the prophet Isaiah has these remarkable words; "Thy dead men shall live; together with my dead body shall they arise. Awake and sing, ye that dwell in the dust; for thy dew is as the dew of herbs, and the earth shall cast out the dead *." We agree with Bishop Warburton that these words are figurative, and that they were uttered to give the Israelites consolation in very disastrous times. The purpose of the prophet was to assure them, that though their community should, in Babylon, be as completely dissolved as a dead body reduced to dust, yet God would restore them to their own land, and raise that community again to life. This was indeed a prophecy only of a temporal deliverance; but as it is expressed in terms relating to the death and resurrection of man, the doctrine of a resurrection must then have been well known, and generally received, or such language would have been altogether unintelligible.

156 This opinion confuted.

* Chap. xxvi. 19.

The prophet Ezekiel, when the state of things was most desperate, is carried by the Spirit into a valley full of dry bones, and asked this question; "Son of man, can these bones live?" To which he answers: "O Lord God, though knowest †." He was not asked if *all* the dead would rise at the last day; but only if the particular bones *then* presented to him could live at *that time*, and while other bones were mouldering in corruption: and to such a question we cannot conceive any answer that a man brought up in the belief of a general resurrection could have given, but—"O Lord God, thou knowest." Had Ezekiel been a stranger to the doctrine of a general resurrection, or had he not believed that doctrine, he would doubtless have answered the question that was put to him in the negative; but convinced that *all* men are at *some* period to rise from the dead, "that every one may receive the things done in his body, according to that he hath done, whether it be good or bad," he very naturally said, that God alone knew whether the bones then exhibited to him in the valley would rise before the general resurrection.

† Chap. xxxvii. 3.

157 The hope of the Hebrews, however, not from their own law,

But though the more intelligent and righteous Israelites certainly "all died in faith, and not having received the promises, but having seen them afar off, were persuaded of them and embraced them, confessing that they were strangers and pilgrims on earth, who desired a better country, that is, a heavenly one ‡," we are not to suppose that this heavenly desire arose from any thing taught in the law of Moses. That law, when taken by itself, as unconnected with prior and subsequent revelations, makes no mention whatever of a heavenly inheritance, which St Paul assures us § was given 420 years before to Abraham by a promise which may be traced back to the first ray of comfort vouchsafed to fallen man in the sentence passed on the original deceiver. "Wherefore then served the law? It was added (says the apostle), because of transgressions, till the seed should come to whom the promise was made." The transgressions here alluded to were polytheism and idolatry, which, with a train of cruel and detestable vices, had overspread the whole world; and the primary attention of the law was to stem the torrent of these corruptions, for which we have seen it was admirably calculated; and, like a schoolmaster, to instruct the Israelites in the unity and worship of Jehovah, and thus by degrees bring them to Christ.

‡ Heb. xi. 3, &c.

§ Gal. iii. 16—19.

But

But though it is apparent that a future state of rewards and punishments made no part of the Mosaic dispensation, yet the law had certainly a spiritual meaning to be understood when the fulness of time should come. Every Christian sees a striking resemblance between the sacrifice of the paschal lamb, which delivered the Israelites from the destroying angel in Egypt, and the sacrifice of the Lamb of God, which taketh away the sin of the world. Indeed the whole ritual of sacrifice must have led the more intelligent of them to faith in a future sacrifice; by which, while the heel of the seed of the woman should be bruised, the head of the serpent should be completely crushed (see SACRIFICE); and as prophets were raised up from time to time, to prepare them for the coming of the Messiah, and to foretel the nature of his kingdom, there can be no doubt but that those inspired teachers would lay open to them, as far as was expedient, the temporary duration of the Mosaic

158 Why the law was typical.

law, and convince them that it was only the shadow of better things to come. From the nature of their ritual, and the different prophecies vouchsafed them, which became more and more explicit as the time approached for their accomplishment, they must surely have been led to expect redemption from the curse of the fall by the sufferings of their Messiah; but that any one of them knew precisely the *manner* in which they were to be redeemed, and the nature of that religion which was to supersede their own, is wholly incredible. Such knowledge would have made them impatient under the yoke of ordinances to which they were subjected; for after the Christian faith came into full splendour, mankind could be no longer under the tuition of such a schoolmaster as the law, which "had only a *shadow* of good things; and so far from their reality, not even the very *image* of them*." Through these shadows, however, the Jews, aided by the clearer light of prophecy, though it too shone in a dark place, might have seen enough of God's plan of redemption to make them acknowledge Jesus of Nazareth, when he came among them working miracles of mercy, for the Messiah so long promised to their forefathers, and in whom it was repeatedly said, that all the nations of the earth should be blessed.

* Heb. x. 1.

159 Means used to prepare the world for the coming of Christ.

While such care was taken to prepare the descendants of Abraham for the coming of the Prince of Peace, we must not suppose that God was a respecter of persons, and that the rest of the world was totally neglected. The dispersion of the ten tribes certainly contributed to spread the knowledge of the true God among the eastern nations. The subsequent captivity of the tribes of Judah and Benjamin must have confirmed that knowledge in the great empires of Babylon and Persia; and that particular providence of God which afterwards led Ptolemy Philadelphus to have the Jewish scriptures translated into the Greek language, laid the divine oracles open to the study of every accomplished scholar. At last, when the arms of Rome had conquered the civilized world, and rendered Judea a province of the empire; when Augustus had given peace to that empire, and men were at leisure to cultivate the arts and sciences; when the different sects of philosophers had by their disputations whetted each others understandings, so that none of them was disposed to submit to an imposture; and when the police of the Roman government was such that intelligence of every thing important was quickly transmitted from the most distant provinces to the capital of the empire; "when that fulness of time was come, God sent forth his Son made of a woman, made under the law, to redeem them that were under the law, that we might receive the adoption of sons," and be restored to that inheritance of which the forfeiture introduced the several dispensations of revealed religion into the world.

SECT. V. *View of Theology more peculiarly Christian.*

MANKIND being trained by various dispensations of providence for the reception of Jesus Christ, and the time fixed by the prophets for his coming being arrived, "a messenger was sent before his face to prepare his way before him by preaching the baptism of repentance for the remission of sins." This messenger was John the Baptist, a very extraordinary man, and the greatest of all the prophets. His birth was miraculous, the scene of his ministry the wilderness, his manners austere, and his preaching upright, without respect of persons. He frankly told his audience that he was not the Messiah, that the Messiah would soon appear among them, that "he was mightier than himself, and that he would baptize them with the Holy Ghost and with fire."

160 Christ the divine word incarnate.

Mightier indeed he was; for though born of a woman the Messiah was not the son of a human father; and though living for the first thirty years of his life in obscurity and poverty, he was the lineal descendant of David, and heir to the throne of Israel. But the dignity of his human descent, great as it was, vanishes from consideration when compared with the glory which he had with his Father before the world was. The Jewish dispensation was given by the ministry of Moses, and illustrated by subsequent revelations vouchsafed to the prophets; the immediate author of the Christian religion is the λογος or the second person of the blessed Trinity, of whom St John declares, that "he was in the beginning with God, and was God; that all things were made by him; and that without him was not any thing made that was made." We have already proved that in the one Godhead there is a Trinity of persons; and that the λογος is one of the three, is apparent from these words of the apostle, and from many other passages of sacred scripture. Thus he is called *the Lord of hosts himself; the first and the last, besides whom there is no God; the most high God; God blessed for ever; the mighty God, the everlasting Father, Jehovah our righteousness;* and *the only wise God our Saviour* (B). This great Being, as the same apostle assures us, was made flesh, and dwelt among men; not that the divine nature was or could be changed into humanity, for God is immutable, the same almighty and incomprehensible Spirit,

(B) Isaiah viii. 13, 14. compared with 1 Peter ii. 7, 8.; Isaiah vi. 5. compared with John xii. 41.; Isaiah xliv. 6. compared with Revelation xxii. 13.; Psalm lxxviii. 56. compared with 1 Corinthians x. 9. Romans ix. 5. Isaiah ix. 6. Jeremiah xxiii. 6. Jude.

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Spirit yesterday, to-day, and for ever; but the Word or second person in the godhead, assuming a human soul and body into a personal union with himself, dwelt upon earth as a man, veiling his divinity under mortal flesh. Hence he is said elsewhere to have been "manifested in the flesh," and "to have taken upon him the nature of man;" phrases of the same import with that which asserts "the WORD to have been made flesh."

161 Objections to the incarnation of the Word.

This incarnation of the Son of God is perhaps the greatest mystery of the Christian faith, and that to which ancient and modern heretics have urged the most plausible objections. The doctrine of the Trinity is indeed equally incomprehensible; but the nature of God and the mode of his subsistence, as revealed in scripture, no man, who thinks, can be surprised that he does not comprehend; for a revelation which should teach nothing mysterious on such a subject would be as incredible and as useless as another which contained nothing but *mystery*. The difficulty respecting the incarnation, which forces itself on the mind, is not how two natures so different as the divine and human can be so intimately united as to become one person; for this union in itself is not more inconceivable than that of the soul and body in one man; but that which at first is apt to stagger the faith of the reflecting Christian is the infinite distance between the two natures in Christ, and the comparatively small importance of the object, for the attainment of which the eternal Son of God is said to have taken on him our nature.

162 Obviated.

Upon mature reflection, however, much of this difficulty will vanish to him who considers the ways of Providence, and attends to the meaning of the words in which this mystery is taught. The importance of the object for which the WORD condescended to be made flesh, we cannot adequately know. The oracles of truth indeed inform us, that Christ Jesus came into the world to save sinners; but there are passages scattered through the New Testament * which indicate, not obscurely, that the influence of his sufferings extends to other worlds besides this: and if so, who can take on him to say, that the quantity of good which they may have produced was not of sufficient importance to move even to this condescension a Being who is emphatically styled LOVE?

* Eph. i. 10. Col. i. 19, 20.

But let us suppose that every thing which he did and taught and suffered was intended only for the benefit of man, we shall, in the daily administration of providence, find other instances of the divine condescension; which, though they cannot be compared with the incarnation of the second person in the blessed Trinity, are yet sufficient to reconcile our understandings to that mystery when revealed to us by the Spirit of God. That in Christ there should have dwelt on earth "all the fulness of the Godhead bodily †," is indeed a truth by which the devout mind is overwhelmed with astonishment; but it is little less astonishing that the omnipotent Creator should be intimately present at every instant of time to the meanest of his creatures, "upholding all things, the vilest reptile as well as the most glorious angel, by the word of his power ‡." Yet it is a truth self-evident, that without this constant presence of the Creator, nothing which had a beginning could continue one moment in being; that the visible universe would not only crumble into chaos, but vanish into nothing; and that the souls of men, and even the most exalted spirits of creation, would instantly lose that existence, which, as it was not of itself, and is not necessary, must depend wholly on the will of Him from whom it was originally derived. See METAPHYSICS, N° 272—276, and PROVIDENCE, N° 3.

† Col. ii.

‡ Heb. i. 3.

In what particular way God is present to his works, we cannot know. He is not diffused through the universe like the *anima mundi* of the ancient Platonists, or that modern idol termed the *substratum of space* (METAPHYSICS, N° 309, 310): but that he is in power as intimately present now to every atom of matter as when he first brought it into existence, is equally the dictate of sound philosophy and of divine revelation; for "in him we live and move and have our being;" and power without substance is inconceivable. If then the divine nature be not debased, if it cannot be debased by being constantly present with the vilest reptile on which we tread, why should our minds recoil from the idea of a still closer union between the second person of the ever blessed Trinity and the body and soul of Jesus Christ? The one union is indeed different from the other, but we are in truth equally ignorant of the nature of both. Reason and revelation assure us that God must be present to his works to preserve them in existence; and revelation informs us farther, that one of the persons in the Godhead assumed human nature into a personal union with himself, to redeem myriads of rational creatures from the miserable consequences of their own folly and wickedness. The importance of this object is such, that, for the attainment of it, we may easily conceive that he who condescends to be potentially present with the worms of the earth and the grass of the field, would condescend still farther to be personally present with the spotless soul and body of a man. Jesus Christ lived indeed a life of poverty and suffering upon earth, but his divine nature was not affected by his sufferings. At the very time when, as a man, he had not a place where to lay his head; as God, he was in heaven as well as upon earth *, dwelling in light inaccessible; and while, as a man, he was increasing in wisdom and stature, his divinity was the fulness of him who filleth all in all, and from whom nothing can be hid.

* John iii. 13.

Perhaps the very improper appellation of *mother of God*, which at an early period of the church was given to the Virgin Mary, may have been one cause of the reluctance with which the incarnation has been admitted; for as we have elsewhere observed (see NESTORIUS), such language, in the proper sense of the words, implies what those, by whom it is used, cannot possibly believe to be true; but it is not the language of scripture. We are there taught, that "Christ being in the form of God, thought it no robbery to be equal with God; but made himself of no reputation, and took upon him the form of a servant, and was made in the likeness of man †;" that "God sent forth his Son made of a woman, made under the law, to redeem them that were under the law, that we might receive the adoption of sons ‡;" and that "the WORD who was in the beginning with God, and was God, by whom all things were made, was made flesh, and dwelt among men (who beheld his glory, the glory as of the only begotten of the Father), full of grace and truth §:" but we are nowhere taught that, as God, he had a mother! It was indeed the doctrine of the primitive church ‖, that the very principle of personality and individual existence in Mary's

† Philip. ii. 6, 7.

‡ Gal. iv. 4, 5.

§ John i.

‖ Horsley's *Sermon on the Incarnation.*

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Mary's son, was union with the uncreated Word; and this doctrine is thought to imply the miraculous conception, which is recorded in the plainest terms by two of the evangelists; for he was conceived by the Holy Ghost and born of a virgin *; but, as God, he had been begotten from all eternity of the Father, and in order of nature was prior to the Holy Ghost. This is evident from the appellation of ὁ λογος given to him by St John; for the term being used in that age, both by the Jewish rabbies and the heathen philosophers, to denote the second divine subsistence, which they considered as an eternal and necessary emanation from the first, sometimes called τ'αγαθον and sometimes το ἑν; and the apostle giving no intimation of his using the word in any uncommon sense, we must necessarily conclude, that he meant to inform us that the divinity of Christ is of eternal generation. That the term λογος was used in this sense by the later Platonists, and in all probability by Plato himself, we have sufficiently shewn in another place (see PLATONISM); and that a similar mode of expression prevailed among the Jews in the time of St John, is apparent from the Chaldee paraphrase; which, in the 110th psalm, instead of the words "the Lord said unto my Lord," has, "the Lord said unto his WORD." Again, where we are told in the Hebrew that Jehovah said to Abraham †, "I am thy shield and thy exceeding great reward," we read in the Chaldee, "my WORD is thy shield, and thy exceeding great reward." Where it is said, "your new moons and your appointed feasts my soul hateth ‡," the paraphrast hath it, "my WORD hateth;" and where it is said, that "Israel shall be saved in the Lord with an everlasting salvation §," in the same paraphrase it is, "Israel shall be saved by the WORD of the Lord with everlasting salvation." But there is a passage in the Jerusalem Targum which puts it beyond a doubt, that by the λογος the Jews understood a divine person begotten of his Father before all worlds; for commenting on Genesis iii. 22. the authors of that work thus express themselves: "The WORD of the Lord said, behold Adam, whom I created, is the only begotten upon earth, as I AM THE ONLY BEGOTTEN IN HEAVEN:" in conformity with which, Philo introduces ‖ the Logos speaking thus of himself; Και γαρ ουτε αγεννητος ως θεος ων, ουτε γεννητος ως υμεις. *I am neither unbegotten, as God, nor begotten after the same manner as you are.*

163 His divine nature begotten of the Father.

* Matth. i. 18, &c. Luke i. 27. &c.

† Gen. xv. 1.

‡ Isaiah i. 14.

§ Isaiah xlv. 17.

‖ *De Agricult.* lib. ii.

164 Orthodoxy of the Nicene creed.

From these quotations we may justy conclude, that the Nicene fathers expressed themselves properly when they declared that the only begotten Son of God was begotten of his father before all worlds, and is God of God; for if St John had believed the λογος or WORD to be unbegotten, contrary to the belief of all who made use of the phrase at the time when he wrote, he would surely have expressed his dissent from the generally received opinion. This however he is so far from doing, that he gives the amplest confirmation of that opinion, by declaring, that "he beheld the glory of the WORD incarnate as the glory of the only begotten of the Father;" for this declaration is true only of the divinity of Christ, his human nature not being begotten of the Father, but conceived by the Holy Ghost of the Virgin Mary. Hence our blessed Lord assures us, that "as the Father HATH life in HIMSELF, so hath he GIVEN the Son to have life in himself;" that "the Son can do nothing of *himself*, but what he seeth the Father do *;" and that "he knew the Father, because he was from him and sent by him †." We must therefore agree with Bishop Pearson (c), that "though the Father and Son are both truly God, and therefore equal in respect of nature, yet the one is greater than the other, as being the fountain of the Godhead. The Father is God, but *not of God*; Light, but *not of Light*. Christ is God, but *of* God; Light, but *of* Light. There is no difference or inequality in the nature or essence, because the same in both; but the Father of our Lord Jesus Christ hath that essence of himself, from none; Christ hath the same essence, not of himself, but from him."

* St John v. 26. 19.

† John vii. 29.

165 Purpose for which Christ was sent into the world.

The great purpose for which this divine person was sent into the world, was to bruise the head of the serpent, and restore mankind to the inheritance which had been forfeited by Adam's transgression. Every dispensation of Providence from the fall had been preparatory to this restoration. Prophets had been raised from time to time to preserve in the early ages of the world the knowledge and worship of the true God: the children of Abraham had been separated from the surrounding nations for the same purpose; and by the dispersion of the ten tribes, the captivity of the other two in Babylon, and the translation of the Hebrew scriptures into the Greek language, much of the knowledge which had been revealed to the Israelites was gradually diffused over the eastern world.

But while the Jews were thus rendered the instruments of enlightening the heathen nations of antiquity, their intercourse with those nations made them almost unavoidably acquainted with the philosophy which was cultivated among the Chaldeans, the Persians, and the Egyptian Greeks; and ingrafting many of the opinions derived from those schools upon the doctrines of Moses and the prophets, they corrupted their own religion while

(c) We beg leave to recommend to our readers this author's excellent exposition of the apostle's creed, as a work which will render them great assistance in acquiring just notions of the fundamental articles of the Christian faith. They will find it, we think, a complete antidote against the poison of modern Unitarians and modern Tritheists; of whom the former teach that Jesus Christ was a mere man, the son of Joseph as well as of Mary; while the latter, running to the other extreme, maintain, that, with respect to his divinity, he is in no sense subordinate to the Father, but might have been the Father, the Son, or the Holy Ghost, according to the good pleasure of the eternal three. We have been at some pains to prove his divinity, and likewise his eternal generation; but in such a short compend as we must give, it seems not to be worth while to prove his miraculous conception. That miracle is plainly asserted in the New Testament in words void of all ambiguity; and as it is surely as easy for God to make a man of the substance of a woman as of the dust of the earth, we cannot conceive what should have induced any person professing Christianity to call it in question. The natural generation of Christ is a groundless fancy, which can serve no purpose whatever, even to the Unitarians.

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while they improved that of their neighbours. Hence, by the time that Christ came among them, they had made the word of God of none effect through a number of idle fancies which they inculcated on the people as the traditions of the elders; and as they had attached themselves to different masters in philosophy, their unauthorised opinions were of course different according to the different sources whence they were drawn. The peculiar tenets of the ESSENES seem to have been a species of mystic Platonism. The PHARISEES are thought to have derived their origin from a Jewish philosopher of the Peripatetic school; and the resemblance between the doctrines of the SADDUCEES and the philosophy of Epicurus has escaped no man's observation.

166 Corruption of the Jews at the time of his coming.

Though these sects maintained mutual communion in public worship, they abhorred each other's distinguishing tenets; and their wranglings had nearly banished from them every sentiment of true religion. They agreed, however, in the general expectation of the Messiah promised to their fathers; but, unhappily for themselves, expected him as a great and temporal prince. To this mistake several circumstances contributed: some of their prophets had foretold his coming in lofty terms, borrowed from the ritual law, and the splendour of earthly monarchs. The necessity of casting this veil over those living oracles we have shewn in another place (see PROPHECY, N° 17.). At the time when the predictions were made, the Mosaic system had not run out half its course, and was therefore not to be exposed to popular contempt by an information, that it was only the harsh rudiment of one more easy and perfect. To prevent, however, all mistakes in the candid and impartial, when the Messiah should arrive with the credentials of miraculous powers, other prophets had described him in the clearest terms as having no form nor comeliness, as a sheep dumb before his shearers, and as a lamb brought to the slaughter; but the Jews had suffered so much from the Chaldeans, the Greeks, and other nations by whom they had been conquered, and were then suffering so much from their masters the Romans, that they could think of no deliverance greater than that which should rescue their nation from every foreign yoke.

What men earnestly wish to be true, they readily believe. Hence that people, losing sight of the yoke under which they and the whole human race were brought by the fall of Adam, mistaking the sense of the blessing promised to all nations through the seed of Abraham, and devoting their whole attention to the most magnificent descriptions of the Messiah's kingdom, expected in him a prince who should conquer the Romans, and establish on earth a universal monarchy, of which Jerusalem was to be the metropolis.

167 The objects of his preaching.

As our Saviour came for a very different purpose, the first object of his mission was to rectify the notions of his erring countrymen, in order to fit them for the deliverance which they were to obtain through him. Accordingly, when he entered on his office as a preacher of righteousness, he embraced every opportunity of inveighing against the false doctrines taught as traditions of the elders; and by his knowledge of the secrets of all hearts, he exposed the vile hypocrisy of those who made a gain of godliness. The Jews had been led, by their separation from the rest of the world, to consider themselves as the peculiar favourites of Jehovah; and the consequence was, that, contrary to the spirit of their own law, and the explicit doctrines of some of their prophets, they looked on all other nations with abhorrence, as on people physically impure. These prejudices the blessed Jesus laboured to eradicate. Having desired a lawyer, by whom he was tempted, to read that part of the law of Moses which commanded the Israelites to love their neighbours as themselves, he compelled him, by means of a parabolical account of a compassionate Samaritan, to acknowledge, that under the denomination of neighbour the divine lawgiver had comprehended all mankind as the objects of love *. The importance in which Moses held the ritual law, and to which, as the means of preserving its votaries from the contagion of idolatry, it was justly intitled, had led the Jews to consider every ceremony of it as of intrinsic value and perpetual obligation: but Jesus brought to their recollection God's declared preference of mercy to sacrifice; shewed them that the weightier matters of the law, judgment, mercy, and faith, claimed their regard in the first place, and its ceremonial observances only in the second; and taught them, in conformity with the predictions of their own prophets †, that the hour was about to come when the worship of God should not be confined to Jerusalem, but that "true worshippers should everywhere worship the Father in spirit and in truth ‡."

* St Luke x. 25—38.

† Jeremiah xxxi. 31. &c.

‡ John iv. 25—27.

It being the design of Christ's coming into the world to break down the middle wall of partition between the Jews and Gentiles, and to introduce a new dispensation of religion which should unite all mankind as brethren in the worship of the true God, and fit them for the enjoyment of heaven; he did not content himself with merely restoring the moral part of the Mosaic law to its primitive purity, disencumbered of the corrupt glosses of the Scribes and Pharisees, but added to it many spiritual precepts, which, till they were taught by him, had never occurred either to Jew or Gentile. The Hebrew lawgiver had prohibited murder under the penalty of death; but Christ extended the prohibition to causeless anger, and to contemptuous treatment of our brethren, commanding his followers, as they valued their everlasting salvation, to forgive their enemies, and to love all mankind. Adultery was forbidden by the law of Moses as a crime of the deepest dye; but Jesus said to his disciples, "that whosoever looketh on a woman to lust after her, hath committed adultery with her already in his heart," and is of course liable to the Divine vengeance. The *lex talionis* was in force among the Jews, so that the man who had deprived his neighbour of an eye or a tooth, was to suffer the loss of an eye or a tooth himself; but this mode of punishment, which inflicted *blemish* for *blemish*, though suited to the hardness of Jewish hearts, being inconsistent with the mild spirit of Christianity, was abolished by our blessed Lord, who severely prohibited the indulgence of revenge, and commanded his followers to love even their enemies. Perjury has in every civilized nation been justly considered as a crime of the highest atrocity, and the Mosaic law doomed the false witness to bear the punishment, whatever it might be, which he intended by swearing falsely to bring on his brother; but the Author of the Christian religion forbade not only false swearing, but swearing at all, except on solemn occasions, and when an oath should be required by legal authority. See OATH.

By thus restoring the law to its original purity, and in

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in many cases extending its sense, the blessed Jesus executed the office of a PROPHET to the lost sheep of the house of Israel; but had he not been more than an ordinary prophet, he could not have abrogated the most trivial ceremony of it, nor even extended the sense of any of its moral precepts; for their great lawgiver had told them, that "the Lord their God would raise up unto them but one Prophet, like unto him, to whom they should hearken ‡." That Prophet was by themselves understood to be the Messiah, whom they expected to tell them all things. It was necessary therefore that Jesus, as he taught some new doctrines, and plainly indicated that greater changes would soon be introduced, should vindicate his claim to that exalted character which alone could authorise him to propose innovations. This he did in the amplest manner, by fulfilling prophecies and working miracles (See MIRACLE and PROPHECY); so that the unprejudiced part of the people readily acknowledged him to be of a truth "that prophet which should come into the world—the Son of God, and the King of Israel." He did not, however, make any change in the national worship, or assume to himself the smallest civil authority. He had submitted to the rite of circumcision, and strictly performed every duty, ceremonial as well as moral, which that covenant made incumbent on other Jews; thus fulfilling all righteousness. Though the religion which he came to propagate was in many respects contrary to the ritual law, it could not be established, or that law abrogated, but in consequence of his death, which the system of sacrifices was appointed to prefigure; and as his kingdom, which was not of this world, could not commence till after his resurrection, he yielded during the whole course of his life a cheerful obedience to the civil magistrate, and wrought a miracle to obtain money to pay the tribute that was exacted of him. Being thus circumstanced, he chose from the lowest and least corrupted of the people certain followers, whom he treated with the most endearing familiarity for three years, and commissioned at his departure to promulgate such doctrines as, consistently with the order of the divine dispensations, he could not personally preach himself. With these men, during the course of his ministry on earth, he went about continually doing good, healing the sick, casting out devils, raising the dead, reproving vice, preaching righteousness, and instructing his countrymen, by the most perfect example which was ever exhibited in the world, of whatsoever things are true, or honest, or just, or pure, or lovely, or of good report. The Scribes and Pharisees, however, finding him not that conqueror whom they vainly expected, becoming envious of his reputation among the people, and being filled with rancour against him for detecting their hypocritical arts, delivered him up to the Roman governor, who, though convinced of his innocence, yielded to the popular clamour, and crucified him between two thieves, as an enemy to Cæsar.

168 In which he executed the office of a prophet.

‡ Deut. xviii. 15.

169 His strict obedience to the law.

Just before he expired, he said, It is finished, intimating that the purpose was now fulfilled for which he had come into the world, and which, as he had formerly told his disciples, "was not to be ministered unto, but to minister, and to give his life a ransom for many ||." For his blood, as he assured them at the institution of the Eucharist, "was to be shed for the remission of sins." That Christ died voluntarily for us, the just for the unjust, and that "there is none other name under heaven given among men whereby we must be saved," is the uniform doctrine of the prophets who foretold his coming, of John the Baptist who was his immediate harbinger, and of the apostles and evangelists who preached the gospel after his ascension into heaven. Thus Isaiah says of the Messiah §, that "he was wounded for our transgressions, and bruised for our iniquities; that the chastisement of our peace was upon him, and that with his stripes we are healed; that we had all like sheep gone astray, turning every one to his own way, and that the Lord laid on him the iniquity of us all; that he was cut off out of the land of the living, and stricken for the transgression of God's people; and his soul or life was made an offering for sin; and that he bore the sin of many, and made intercession for the transgressors." The Baptist, "when he saw Jesus coming unto him, said to the people, Behold the Lamb of God, which taketh away the sin of the world;" plainly intimating that his death was to be a sacrifice, since it was only as a sacrifice that the Jews could form any conception of a lamb taking away sin. The epistles of St Paul are so full of the doctrine of Christ's satisfaction, that it is needless to quote particular texts in proof of it. He tells the Romans, that Jesus Christ was set forth to be a propitiation through faith in his blood; he was delivered for our offences, and raised again for our justification; that he died for the ungodly; and that God commendeth his love towards us, in that while we were yet sinners Christ died for us." He assures the Corinthians that Christ died for all; that "they who live should not henceforth live unto themselves, but to him who died for them and rose again; and that God made him to be sin for us, who knew no sin, that we might be made the righteousness of God in him." He informs the Galatians, that Christ "gave himself for our sins, that he might deliver us from this present evil world, according to the will of God and our Father; and that he redeemed us from the curse of the law, being made a curse for us." St Peter and St John speak the very same language; the former teaching us, that "Christ suffered for us, and bare our sins in his own body on the tree †; the latter, that the blood of Jesus Christ cleanseth us from all sin, and that he is the propitiation for our sins; and not for our sins only, but also for the sins of the whole world ‡." That he came into the world for the purpose of suffering, appears from his own words: for "no man (said he §) taketh my life from me, but I lay it down of myself: I have power to lay it down, and I have power to take it again. This commandment have I received from my Father." And that he voluntarily laid it down for mankind, is evident from his calling himself the Good Shepherd, and adding, that "the Good Shepherd giveth his life for the sheep ||."

|| Mat. xx. 28.

170 He voluntarily died for us.

§ Chap. liii.

† 1 Peter ii. 21, and 24.

‡ 1 John i. 7. ii. 2.

§ 1 John x. 18.

|| Ibid ver. 11.

That Christ died for the benefit of the human race, is a truth so apparent from these texts, that no man professing Christianity has hitherto called it in question. Very different opinions have been formed indeed concerning the nature and extent of that benefit, and the means by which it is applied; but that the passion and death of the blessed Jesus were essential parts of his ministry on earth, has seldom been controverted. That on the cross he made satisfaction to his Father for the sins of the world, is the general belief of Christians; but presumptuous men, aming at being wise beyond what is written, have started a thousand idle questions concerning the necessity of

171 Different opinions respecting the nature and extent of the benefit reaped from his death.

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of such satisfaction, and the manner in which it was made. Some limiting the power and mercy of the Omnipotent, have dared to affirm that God *could not* have pardoned man without receiving full satisfaction for his offences; that nothing but the shedding of the blood of Christ could make that satisfaction; that his death was indeed sufficient to atone for a thousand worlds; that, however, he did not die for all mankind, but only for a chosen few, ordained to eternal life by a secret decree before the foundation of the world; and that the rest of the race are passed by, and doomed to eternal perdition, for the glory of God's justice. Others, convinced by every thing around them that the Creator and Governor of the universe is a being of infinite benevolence, whose only end in giving life must have been to communicate happiness, have contended, that no atonement whatever could be necessary to obtain from him the forgiveness of sin on sincere repentance; that it is contrary to all our notions of justice to punish the innocent for the guilty; and that therefore the death of Christ, though the essential part of his ministry, could not be necessary, but at the most expedient.

We enter not into these debates. The Scriptures have nowhere said what God could or could not do; and on this subject we can know nothing but what they have taught us. That "we are reconciled to God by the death of his Son," is the principal doctrine of the New Testament; and without presuming to limit the power, the mercy, or the wisdom, of him who created and sustains the universe, we shall endeavour to show that it is a doctrine worthy of all acceptation. In doing this, we shall state impartially the opinions which pious men have held respecting the form or manner in which Christ by his death made satisfaction to God for the sins of the world; and we hope that our readers will embrace that opinion which shall appear to them most consonant to the general sense of sacred Scripture.

172 Opinions of the Calvinists.

The strictest adherents to the theological system of Calvin, interpreting literally such texts of Scripture as speak of his being *made sin* for us, of his *bearing our sins in his own body on the tree*, and of the Lord's *laying on him the iniquity of us all*, contend, that the sins of the elect were lifted off from them and laid on Christ by *imputation*, much in the same way as they think the sin of Adam is imputed to his posterity. "By bearing the sins of his people (says Dr Gill†) he took them off from them, and took them upon himself, bearing or carrying them, as a man bears or carries a burden on his shoulders. There was no sin *in* him inherently, for if there had, he would not have been a fit person to make satisfaction for it; but sin was *put* upon him by his Divine Father, as the sins of the Israelites were put upon the scape-goat by Aaron. No creature (continues he) could have done this; but the LORD hath laid on him, or made to meet on him, the iniquity of us all, not a single iniquity, but a whole mass and lump of sins collected together; and laid as a common burden upon him; even the sins of all the elect of God. This phrase of laying sin on Christ is expressive of the *imputation* of it to him; for it was the will of God not to impute the transgressions of his elect to themselves, but to Christ, which was done by an act of his own; for he hath made him to be sin for us: that is, by *imputation*, in which way we are made the righteousness of God in him; that being imputed to us by him as our sins were to Christ. The sense (says our author) is, a charge of sin was brought against him as the surety of his people. He was numbered with the transgressors; for bearing the sins of many, he was reckoned as if he had been a sinner himself, sin being *imputed* to him; and he was dealt with as such. Sin being found upon him by *imputation*, a demand of satisfaction for sin was made, and he answered it to the full. All this was with his own consent. He *agreed* to have sin laid upon him, and *imputed* to him, and a charge of it brought against him, to which he engaged to be responsible; yea, he himself took the sins of his people upon him; so the evangelist Matthew has it, 'He himself took our infirmities, and bore our sicknesses ‡.' As he took the nature of men, so he took their sins, which made his flesh to have *the likeness of sinful flesh*, though it really was not sinful. What Christ bore being laid upon him, and imputed to him, were *sins* of all sorts, original and actual; sins of every kind, open and secret, of heart, lip, and life; all acts of sin committed by his people, for he has redeemed them from all their iniquities; and God, for Christ's sake, forgives all trespasses, his blood cleanses from all sin, and his righteousness justifies from all; all being imputed to him as that is to them. Bearing sin supposes it to be a burden; and indeed it is a burden too heavy to bear by a sensible sinner (E). When sin is charged home upon the conscience, and a saint groans, being burdened with it, what must that burden be, and how heavy the load which Christ bore, consisting of all the sins of all the elect from the beginning of the world to the end of it; and yet he sunk not, but stood up under it; failed not, nor was he discouraged, being the mighty God, and the Man of God's right hand, made strong for himself."

† Body of Divinity, vol. ii. book iii. chap. v. § 4.

‡ Chap. viii. 17.

173 Objected to.

To the Arminians or Remonstrants, this doctrine of the imputation of the sins of men to the Son of God appears as absurd as the similar doctrine of the imputation of the sin of Adam to his unborn posterity; and it is certainly attended with consequences which have alarmed serious Christians of other denominations.

Were it possible in the nature of things, says the Arminian, to transfer the guilt of one person to another, and to lay it upon him as a burden, it could not be done without violating those laws of equity which are established in the scripture and engraven on the human heart. But this is not possible. To talk of lifting lumps of sin, or transferring them like burdens from the guilty to the innocent, is to utter jargon, says he, which has no meaning; and we might with as much propriety speak of lifting a scarlet colour from a piece of cloth and laying it on the sound of a trumpet, as of literally lifting the sins of the elect from them and laying them on Christ. Guilt is seated on the mind; and no man can become a sinner but by an act of volition. If Christ therefore *really* took upon him the sins of his people, he must have deliberately formed a wish to have actually committed

(E) By the phrase *a sensible sinner*, the learned author means a sinner who is not past feeling, but has a conscience alive to the sense of remorse.

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committed all these sins; but such a wish, though it would have made him inherently guilty, and therefore incapable of satisfying for sin, could not have cancelled deeds that were done before he was born, or have made those innocent who really had been sinners. A deed once done cannot be undone; a volition which has been formed cannot be annihilated. By sincere repentance, the habitual dispositions are indeed changed, and those who have been sinners become objects of mercy; but no power can recal the hours that are past, or make those actions which have been performed to have been not performed. To remove guilt from the sinner and lay it on the innocent may therefore be safely pronounced impossible even for Omnipotence itself, for it implies that a thing may be and not be at the same instant of time; and the doctrine which teaches that this removal was made from the elect to Christ, is an imagination of yesterday, which has no countenance from scripture, and is contrary to the established constitution of things. Those who imagine that guilt may be propagated from father to son, have something like an argument to urge for the imputation of Adam's sin to his numberless posterity; for all the men and women who have by ordinary generation been introduced into the world, have undoubtedly derived their nature from the primeval pair. But Christ did not derive his nature from the *elect*, that their sins should be communicated to him; nor, as he was miraculously conceived by the Holy Ghost, can we attribute to him any degree of that *taint* which is supposed to have been conveyed from Adam to all the other generations of men.

174
Texts on which they are built explained.

Nothing more, therefore, can be meant by "Christ's being made sin for us," and "bearing our sins in his own body on the tree," or by God's "laying upon him the iniquity of us all," than that by his sufferings we are freed from the punishment of our sins: it being in scripture a common figure of speech, as even Dr Gill has somewhere acknowledged, to denote by the word *sin* the *consequences* of sin. That this figure is used in those texts from which he infers that Christ took the sins of the elect on himself, is evident from the verse which he quotes from the gospel of St Matthew; in which it is said, that "himself took our infirmities and bore our sicknesses." The sicknesses and infirmities there alluded to are the leprosy, the palsy, the fever, and demoniacal possessions: but when our blessed Lord cured these diseases, surely he did not by his omnipotent word lift them off from the patients and take them on himself, so as actually to become a leper, a paralytic, and a dæmoniac, or even to be reckoned as such either by the multitude, or by the priest, whose duty it was to take cognizance of every illegal uncleanness*. And if his inveterate enemies did not *impute* to him the leprosy when he removed that plague from others, why should it be supposed that his own Father, to whom he was at all times well-pleasing, imputed to him the sins of which, by his sufferings, he removed the punishment from those who were guilty? To impute to a person any action, whether virtuous or vicious, which he did not perform, can proceed only from ignorance or malice, or partiality; but God is no respecter of persons, and from ignorance and malice he is removed to an infinite distance. It is indeed an undoubted truth, that "the Lord Jesus, by his perfect obedience and sacrifice of himself, which he through the eternal spirit once offered up unto God, hath fully satisfied the justice of his Father; and purchased not only reconciliation, but an everlasting inheritance in the kingdom of heaven for all those whom the Father hath given him †;" but that he actually took on himself the sins of mankind, or that those sins were imputed to him by God, who punished him as a person whom he considered as guilty, is a doctrine equally injurious to the justice of the Father and to the immaculate purity of the Son.

* Levit. xiii.

† *Confession of Faith*, chap. viii. § v.

175
They have probably contributed to make Socinus deny the doctrine of redemption.

The earnestness with which this doctrine was inculcated by some of the earliest reformers, and the impossibility of admitting it, which every reflecting and unprejudiced mind must feel, was probably one of the causes which drove Socinus and his followers to the other extreme of denying Christ's satisfaction altogether, and considering his death as nothing more than that of an ordinary martyr, permitted for the purpose of attesting the truth of his doctrine, and paving the way for his resurrection, to confirm the great promise of immortality. According to these men, forgiveness is freely dispensed to those who repent, by the essential goodness of God, without regard to the merit or sufferings of any other being; and the gospel is said to save from sin, because it is the most perfect lesson of righteousness. The great objection of *Crellius* to the doctrine of the satisfaction is, that it is a hinderance to piety; for if Christ has paid the whole debt, he thinks that he must have nothing to do, as nothing more can be required of us. And if it were indeed true that our sins are imputed to Christ, and his righteousness imputed to us, this objection would be insurmountable; for God could not justly exact a double punishment for the same sin, or inflict misery on those to whom he imputes perfect righteousness. But as to this imaginary transferring of virtues and vices from one person to another, the scriptures give no countenance; so they nowhere call the death of Christ a *satisfaction* for the sins of men. The term has indeed been long in use among divines, and when properly explained it may be retained without any danger; but in treating of this subject, it would perhaps be more prudent to restrict ourselves to the use of scripture language, as the word *satisfaction* carries in it the ideas of a debt paid and accepted; whereas it is said by St Paul, that "eternal life is the *gift* of God through Jesus Christ our Lord; and that we are justified *freely by his grace* through the redemption that is in Jesus Christ, whom God hath set forth to be a propitiation through faith in his blood."

176
The death of Christ restored to mankind what they had lost.

To clear up this matter, and attain adequate notions of redemption and justification, it will be necessary to look back to the fall of our first parents; for the great purpose for which Christ was promised, and for which he came into the world, was, by bruising the head of the serpent, to restore mankind to the inheritance which they had lost through the transgression of Adam. This is apparent not only from the original promise made to the woman, but also from different passages in the epistles of St Paul, who expressly calls Christ the second Adam, and says, that, "as by the offence of one, judgement came upon all men to condemnation; even so by the righteousness of one, the free gift came upon all men unto justification of life;" that "as by one man's disobedience many were made sinners, so by the obedience of one shall many be made righteous;" and that, "as in Adam all die, even so in Christ shall all be made alive."

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alive." Hence it was that John the Baptist, when he saw Jesus coming to him, said to his disciples †, "Behold the Lamb of God which taketh away, not the *sins*, but the *sin* of the world," evidently alluding to Adam's sin and its consequences, since no other sin was ever committed of which the consequences extend to the whole world.

† Ch. i. ver. 23.

This being the case, it is undeniable, that whatever we lost in the first Adam is restored to us by the second; and therefore they who believe that the punishment denounced against eating the forbidden fruit was death *corporal*, *spiritual*, and *eternal*, must believe that we are redeemed from all these by Christ; who having "appeared once in the end of the world to put away sin by the sacrifice of himself, died for us, that whether we wake or sleep, we should live together with him *." If the image of God in which man was created was lost by the breach of the first covenant, it is more than restored to us "by the Mediator of a better covenant, which is established upon better promises;" if by the sin of Adam we were utterly indisposed, disabled, and made opposite to all that is spiritually good, and wholly inclined to all evil, and that continually, we are freed from that dreadful curse by "our Saviour Jesus Christ who gave himself for us, that he might redeem us from all iniquity, and purify to himself a peculiar people zealous of good works †;" and if for our share in the first transgression we be justly liable to all punishments in this world and in that which is to come, the apostle assures us, that "when we were enemies we were reconciled to God by the death of his Son, because that God was in Christ reconciling the world to himself, not imputing their trespasses unto them ‡." As Jesus is "the Lamb slain in the divine decree from the foundation of the world," these beneficial consequences of his death have been extended by a retrospective view to all in every age whose names are written in the book of life, though it be absurd to suppose that he literally took their sins upon him, and impious to imagine that he suffered under the imputation of sin.

* Heb. ix. 26. 1 Thess. v. 10.

† Titus ii. 14.

‡ Rom. v. 10. 2 Cor. v. 19.

177 Moderate Calvinists and Remonstrants of the same opinion.

Such is the general doctrine of redemption, as it is taught by the more moderate Calvinists and more moderate Remonstrants; for moderate Christians of all denominations, though they express themselves differently, have nearly the same views of the fundamental articles of their common faith. It must not, however, be concealed, that many divines of great learning and piety contend strenuously against the doctrine of vicarious atonement for actual transgressions of the moral law. These are the more zealous Arminians, who deny that we inherit any mortal taint or intellectual weakness from our first parents, whom they believe never to have been in a state of greater perfection than many of their posterity who are called *degenerate*. According to them, we lost nothing by the fall of Adam but our title to eternal life or perpetual existence, together with those graces of the Holy Spirit which were bestowed under the first covenant to train mankind for the society of heaven; and as eternal life and supernatural grace constituted one free gift, not due to the nature of man, or indeed of any created being, they might, when forfeited, be restored by any means or on any condition which should seem expedient to the all-wise Donor. These means, and that condition, human reason cannot indeed discover; but it seems very fit that they should be different from the means by which moral agents under the law of nature can secure to themselves the favour of their Creator, or recover it when occasionally lost. The former depends on arbitrary will and pleasure, or at least on no other principles discoverable by us; while the latter ariseth out of the established and well-known constitution of things. Thus moral virtue, comprehending piety, was the condition of that favour and protection which man, in his original state, could claim from his Maker; but obedience to a positive command was the condition of the free gift of immortality conferred on Adam on his introduction into paradise. The claim arising from the relation between the creature and the Creator is indissoluble, because that relation cannot be dissolved: so that the man who, by a transgression of the moral law has forfeited the favour of God may reasonably hope to recover it by sincere repentance and a return to his duty; and nothing but such repentance and reformation can recover it; because, in a moral agent, nothing can be agreeable to God but moral dispositions, which cannot be transferred from one person to another, and for the want of which nothing can atone. Our virtues are not required nor our vices prohibited, as if the one could profit and the other injure him who created us; for "is it any *pleasure* to the Almighty that we are righteous? or is it *gain* to him that we make our ways perfect? Will he reprove us for *fear* of us?" No? He commands us to be virtuous, and forbids us to be vicious, only because virtue is necessary to our own happiness, and vice productive of everlasting misery.

178 Doctrine of the more zealous Arminians.

Were an immoral man to be introduced into the society of angels and just men made perfect, he would not experience in that society what we are taught to expect from the joys of heaven; because to such joys his acquired dispositions would be wholly repugnant. Nor could the sufferings of any person whatever, or the *imputation* of any extrinsic righteousness, make that mind which had long been immersed in the grossest sensuality relish the intellectual and refined enjoyments of heaven; or the man who had been the habitual slave of envy, malice, and duplicity, a fit inhabitant of that place where all are actuated by mutual love. On the other hand, say the divines whose doctrine we are now detailing, it is impossible to suppose that the Father of mercies, who knows whereof we are made, should have doomed to eternal misery any moral agent who had laboured through life to serve him in sincerity and in truth; or that any atonement could be necessary to redeem from the pains of hell the man whose pious and virtuous dispositions have through penitence and prayer become suited to the society of heaven. Unsinning perfection never was nor ever could be expected in man. He is brought into the world free indeed from vice, but equally destitute of virtue; and the great business of his life is to guard his mind from being polluted by the former, and to acquire dispositions habitually leading to the practice of the latter. Till these habits be fairly formed, it seems impossible that he should not sometimes deviate from the paths of rectitude, and thereby incur a temporary forfeiture of the divine favour; but the very constitution of his mind, and the purpose for which he is placed in a state of probation, show that the divine favour thus forfeited can be recovered only by repentance and reformation.

Widely

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Widely different, however, is the case with respect to the forfeiture and recovery of a free gift, to which man has no natural claim. When the condition is broken on which such a gift was bestowed, repentance can be of no avail; it must be either irrecoverably lost or restored by the mere good pleasure of the giver. Immortality or perpetual existence is a gift which upon certain terms was freely bestowed upon the human race, and forfeited by the transgression of their first parent violating those terms. It was restored by the free grace of God, who was pleased to ordain, that "since by man came death, by man should also come the resurrection of the dead; for as in Adam all die, even so in Christ shall all be made alive. "Hence the apostle, writing to the Romans of the benefits of being the children of God, and joint-heirs with Christ, summeth up those benefits with resurrection from the dead." For the creature, i. e. mankind, was made subject (says he §) to vanity or death, not willingly, but by reason of him who hath subjected the same in hope: because the creature itself also shall be delivered from the bondage of corruption into the glorious liberty of the children of God. For we know that the whole creation groaneth, and travaileth in pain together until now: and not only *they*, but *ourselves* also, who have the first fruits of the spirit, even we ourselves groan within ourselves, waiting for the adoption, viz. *the redemption of our body* (F). That this the redemption of our body is the consequence of the sacrifice of Christ, is taught in the most explicit terms in the epistle to the Hebrews; of which the inspired author informs us, that "forasmuch as the children are partakers of flesh and blood, he also himself likewise took part of the same; that through *death* he might destroy him that had the power of death, that is the devil; and deliver them, who through fear of death were all their lifetime subject to bondage *." A vicarious atonement made with this view, the divines, whose theory we are now considering, acknowledge to be perfectly rational and consistent with the strictest justice. "The law of nature (say they †) allows not of vicarious atonements; but ordains that the man who transgresseth shall himself bear the punishment of his iniquity; a punishment which no man deserves for the faults of another, unless he be partaker of the guilt by joining in the transgression." And in proof of this their opinion, they appeal to the words of God himself, declaring to Moses,—"Whosoever hath sinned against me, him will I blot out of my book ‡." But when the free gift of immortality was lost, it was with great wisdom, say they, that God restored it through a Mediator who should make atonement by his blood for the breach of the first covenant; since such a mediation implies that the gift restored is merely of grace, to the attainment of which man could no further co-operate than by his hopes and wishes.

179 That Christ died to redeem us from the power of the grave.

§ Rom. viii 20—24.

* Heb. ii. 14, 15.

† *Warburton's Div. Leg.* b. ix. and *Law's Considerations on the Theory of Religion*, part iii.

‡ Exod. xxxii. 33— 34.

180 An objection.

To this view of redemption, and indeed to every view of it which we have yet taken, an objection forces itself upon the mind. Throughout the New Testament LIFE AND IMMORTALITY are considered as a *FREE gift*, and called so in express words by St Paul *. To the scheme under consideration it is essential to consider them as such; and yet we know that a large price was paid for them, as St Paul likewise acknowledges, when he twice tells the Corinthians that they were bought with a price †.

* Rom. v. 15.

† Cor. vi. 20. vii. 23.

181 Obviated.

"To clear up this matter (says Bishop Warburton), and to reconcile the apostle to himself, who certainly was not defective either in natural sense or artificial logic, let us once again remind the reader, that life and immortality bestowed on Adam in paradise was a *FREE gift*, as appears from the history of his creation. As a *free gift*, it was taken back by the Donor when Adam fell; to which resumption our original natural rights are not subject, since natural religion teacheth, that sincere repentance alone will reinstate us in the possession of those rights which our crimes had suspended. So that when this free gift, forfeited by the *first* Adam, was recovered by the *second*, its nature continuing the same, it must still remain a *free gift*—a gift to which man, by and at his creation had no claim; a gift which natural religion did not bestow. But if misled by measuring this *revealed mystery* of human redemption by the scant idea of human transactions, where a *free gift* and *purchased benefit* are commonly opposed to one another, yet even here we may be able to set ourselves right, since, with regard to man, the character of a *free gift* remains to *immortality restored*. For the price paid by forfeited man was not paid by him, but by a Redeemer of divine extraction, who was pleased, by participating of man's nature, to stand in his stead. Hence the sacred writers seeing, in this case, the perfect agreement between a *FREE GIFT* and a *PURCHASED POSSESSION*, call it sometimes by the one and sometimes by the other name ‡."

‡ *Div. Leg.* book 9. ch. 2.

182 The death of Christ an atonement only indirectly for actual sin.

A restoration to life and immortality from that state of unconsciousness or extinction, to which all mankind were doomed in consequence of the fall, is that great salvation which we have obtained through the blood of our Redeemer; and according to the theologians whose theory we are now considering, it was the only thing in the divine intention when the promise was given to the first mother that the seed of the woman should bruise the head of the serpent. But though they contend that the death of Christ does not operate, *directly* as atonement for the *actual* sins of men, they admit that it does so *indirectly* and by necessary consequence, since it gives opportunities for repentance and newness of life, which under the first covenant they did not enjoy. Had a man under that covenant transgressed any moral precept, he would have forfeited the favour of his God, and either been subjected to punishment or to a long course of repentance; but supposing the efficacy of repentance under

(F) That by the words *creature* and *creation* the apostle here means all mankind, and by *vanity* and *corruption*, death, the reader will find proved by Dr Whitby, in his note on the place, with a strength of argument which cannot be shaken; and that the whole creation, the Gentiles as well as the Jews, groaned and travailed in pain together under the apprehension of death, is apparent from the writings of Cicero, who always seems doubtful whether death be a good or an evil; and from the lamentation of Hezekiah, when desired by the prophet to set his house in order because he should die and not live.

der the law of nature to be what they suppose it to be, he might before it was perfected have lost his existence by the eating of the forbidden fruit; and thus his penitence or punishment have ended in everlasting death. This can never be the issue of things under the new covenant, which, by the death of Christ, secures immortality to man, and gives to him opportunities, as long as he shall be in a state of probation, of recovering the divine favour when forfeited, whether by a moral transgression or a temporary violation of the peculiar condition of the covenant. Hence they admit the truth of the apostle's doctrine, that we are gainers by the fall of Adam and the redemption wrought by Christ; which will appear when we come to consider their notions of justification. In the mean time it may be proper to observe, that they consider it as no small confirmation of their opinion, that it tends to put an end to the long agitated disputes concerning the *extent* of redemption, and to reconcile passages of scripture which, on the commonly received theories both of Calvinists and Arminians, seem to be at variance with each other.

183 According to the Calvinists Christ died only for the elect.

It is well known to be one of the fundamental doctrines of the Calvinistic school, that "none are *redeemed* by Christ, effectually called, justified, adopted, sanctified, and saved, but the elect only *;" and if the notions of redemption, which, in the end of the 17th century, were very generally embraced, be admitted as just, it will not be easy to overturn the arguments by which that doctrine is supported. Such of them as are connected with the great question of election and reprobation, and enter into the decision of it, we have stated in another place (see PREDESTINATION, N° 14.); but it is farther argued †, that the doctrine of *universal* redemption reflects on the wisdom, the justice, and the power of God, and robs him of his glory.

* *Confession of Faith of the Church of Scotland*, ch. iii. § 6.

† *Gill's Body of Divinity*, vol. ii. book 3. ch. 3.

The scriptures assure us that all men shall not be saved; but how can this be, if Christ died for all, and the scheme of salvation, by his death was formed by infinite wisdom? The Arminians indeed say, that those who fail of salvation, fail through their own fault in not performing the conditions required of them; but God either *knew* or knew *not* that such men would not perform those conditions. If he knew it not, his knowledge is limited; if he did know it, where was his wisdom in providing a scheme of redemption for men to whom he was aware that it would be of no benefit? "God, we are told, is righteous in all his ways, and holy in all his works;" but there is no righteousness in making Christ bear the sins of *all* men, and suffer the punishment due to them, if any one of those men shall be afterwards punished everlastingly. If Christ has already paid the debts of the whole world, it cannot be just to cast a single inhabitant of the whole world into the prison of hell, there to be detained till he shall again have paid the uttermost farthing. "The Lord's hand is not shortened that it cannot save;" for he is and always will be the same Almighty power that he was from eternity; but if by the divine decree Christ died for all men, and yet all men shall not be saved, it would appear that man is mightier than his Maker! The ultimate end of God in the redemption of man is admitted to have been his own glory; but if any individual of the human race, who was redeemed by Christ, shall not be saved, God will so far lose his end, and be deprived of his glory. For, if this were the case, where would be the glory of God the Father in forming a scheme which, with respect to multitudes, does not succeed? and where would be the glory of the Son of God, the Redeemer, in working out the redemption of men who are yet not to be saved by him? and where would be the glory of the spirit of God, if redemption were not by him effectually applied to every individual for whom it was wrought? By such arguments as these do the Calvinists oppose the scheme of universal redemption, and contend that Christ died only for the *elect*, or such as shall be placed on his right hand at the day of judgment. This notion of a limited redemption, as they think it more worthy of the sovereignty of God, they believe to be taught by our Saviour himself, when he saith *, "All that the Father *giveth* me shall come to me; and him that cometh to me, I will in nowise cast out. For I came down from heaven, not to do mine own will, but the will of him that sent me. And this is the Father's will who hath sent me, that of all which he hath *given* me I should lose nothing, but should raise it up again at the last day."

* John vi. 37—40.

184 According to the Arminians he died for all men.

The Arminians, on the other hand, contend, that it is impious to limit the effects of Christ's death to a chosen few, since it appears from scripture, that by the decree and intention of his Father he tasted death for every man, that all, without exception, might through him obtain remission of their sins. Thus our Lord himself told Nicodemus †, that "as Moses lifted up the serpent in the wilderness, even so must the Son of Man be lifted up; that *whosoever* believeth in him, should not perish; but have everlasting life. For God so loved the *world*, that he gave his only begotten Son, that whosoever believeth in him should not perish, but have everlasting life. For God sent not his Son into the world to condemn the world, but that the *world* through him might be saved." In perfect conformity with the doctrine of his divine Master, St Paul teaches ‡, that "Christ died for *all*; that God was in Christ reconciling the *world* to himself, not imputing their trespasses unto them;" that "he will have *all* men to be saved, and to come into the knowledge of the truth;" that "Christ gave himself a ransom for *all*;" and that "Jesus was made a little lower than the angels, that by the grace of God he should taste death for *every man*." The very same thing is taught by St Peter and St John, when the former says §, that "the Lord is not willing that *any* should perish, but that *all* should come to repentance;" and the latter ||, that "Jesus Christ the righteous is the propitiation for our sins; and not for our's only, but for *the whole world*."

† John iii. 14—16.

‡ 2 Cor. v. 14—20. 1 Tim. ii. 4—7. Heb. ii. 9.

§ 2 Peter iii. 9.

|| 1 John ii. 2.

On these texts, without any commentary, the Arminians are willing to rest their doctrine of universal redemption; though they think that a very strong additional argument for its truth arises from the numberless absurdities which flow from the contrary opinion. Thus, say they *, the apostles were commanded by our Saviour † to "go into *all* the world and preach the gospel to *every creature*," and all who hear it preached are required to believe it: but no man, as the Calvinists themselves confess, can believe the gospel as a Christian, without believing that Christ *died for him*; and therefore, if it be true that Christ died only for the *elect*, a great part of mankind are required to believe a lie, and a falsity is made the object of divine faith! Again, if Christ did not die for *all*, then no man can be sure that he

* *Limborch's Theologia Christiana*, Eng. Trans. book 4. ch. iii.

† St Mark xvi. 15, 16.

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he is bound to believe in Christ when preached to him: nor can any man be justly condemned for infidelity: which is not only absurd in itself, but directly contrary to what we are taught by our blessed Lord, who assures us *, that unbelief is the cause of condemnation. Lastly, if Christ died not for *all*, then is it certain that he cannot claim dominion *over all* in *consequence* of his *death* and *resurrection*; but St Paul says expressly †, that "to *this end* Christ both *died*, and *rose*, and *revived*, that he might be the Lord of the *dead* and *living*." The Arminians acknowledge, that though Christ died for all, there are many who will not be saved; for, say they ‡, the death of Christ did not literally pay the debts incurred by sinners, but only obtained for them the gracious covenant of the gospel, by which all who believe in him, and sincerely endeavour to work out their own salvation with fear and trembling, are entitled to forgiveness of sins and eternal life.

* St John iii. 18, 19, and 36.

† Rom. xiv. 9.

‡ *Wells' Div. Laws and Covenants*, part 2. ch. 3.

185 Difficulties removed by the modern Arminians.

Such is the state of this controversy as it was agitated between the Calvinists and Arminians of the 17th century; but the present leaders of this latter school are of opinion, that it never could have been started, had not both parties mistaken the purpose for which Christ died. It is not conceivable, say they, that any thing for which the eternal Son of God took upon him human nature, and in that nature suffered a cruel and ignominious death, shall not be fully accomplished; and therefore, if in the divine intention he died to make atonement for the sins of man actual as well as original, we must of necessity conclude, that those for whom he died shall certainly be saved. Yet we learn from scripture that many shall go away into everlasting punishment, though the same scripture repeatedly assures us that Christ gave his life a ransom for *all*, and that he is the propitiation for *the whole world*. To reconcile these different passages of scripture is impossible, if we suppose that he laid down his life to atone for the *actual* transgressions of men; but if the direct purpose of the Godhead in forming this stupendous plan of redemption was, that the death of Christ should be the ransom of all from the grave or utter extinction, every difficulty is removed; for we know that all, the wicked as well as the righteous, shall through him be raised to life at the last day. That this was the purpose for which he died, they think apparent from the very words quoted by the Calvinists to prove that redemption was not universal; for he declares that it was his Father's will, "that of all which had been given him he should lose nothing." *not* that he should save it all from *future punishment*, but only that he "should raise it up at the last day." When St John calls him a propitiation for our sins, which, as we have seen, the divines whose doctrine we are now stating hold him to be indirectly, he does not add, as in our translation, for the *sins* of the whole world, but περι ὁλου του κοσμου, for the whole world, which, by his death, he redeemed from that vanity and corruption under which, according to St Paul, it had groaned from the fall till the preaching of the gospel. Hence it is that our blessed Lord calls himself "the resurrection and the life," and always promises to those who should believe in him, that though they were dead, yet should they live, and that he would raise them up at the last day.

Among these various opinions respecting the destination of the death of Christ, it belongs not to us to decide. The serious reader, divesting himself of prejudice in favour of the system in which he has been educated, will search the scriptures, and adopt the theory which he shall find most explicitly taught in that sacred volume; but as in every system it is admitted, that *one purpose* for which Christ died was to redeem mankind from the everlasting power of the grave, and bring to light life and immortality, it is of the utmost importance to know whether that purpose has been fully attained. Death we see still triumphing over all the generations of men; and as the scriptures give us no hopes of being rescued from its dominion but through the medium of a resurrection, some sensible evidence seems necessary to evince that a general resurrection shall actually take place. This we are promised as one great benefit purchased for us by the sufferings of Christ sacrificed on the cross. And since the price has been *paid*, and paid thus *visibly*, the nature of the covenant requires that the benefit should be as *visibly enjoyed* by the person whose sufferings obtained it for his brethren. "If the Redeemer himself had not been seen to enjoy the fruits of the redemption procured, what hopes could have remained for the rest of mankind? Would not the natural conclusion have been, that the expedient of *redemption*, by the death and sacrifice of Jesus, had proved ineffectual?" This is the conclusion which St Paul himself draws: "If Christ be not risen (says he *), then is our preaching vain, and your faith is also vain; ye are yet in your sins. Then they also, who are fallen asleep in Christ, are perished—απωλοντο—are lost, as if they had never existed. But now (adds he) is Christ risen from the dead, and become the first fruits of them that *slept*. For since by man came *death*, by man came also the *resurrection* of the dead: For as in Adam *all die*, even so in Christ *shall all be made alive*."—So necessarily connected, in the opinion of the apostle, is the resurrection of Christ with the very essence of Christianity †.

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186 One purpose for which Christ died was to bring to light life and immortality.

* 1 Cor. xv. 15—23.

† *Warburton's Sermon on the Resurrection.*

We have in another place (see RESURRECTION, N° 50.) stated such arguments for the truth of this fundamental article of our common faith, as must carry conviction to every mind capable of estimating the force of evidence; we shall not here resume the subject.

Archbishop King has supposed ‡, that the human will is a faculty distinct from the understanding and the appetites; that activity is essential to it; and that previous to an election formed, it is equally indifferent to all objects. He thence infers, that a man may choose, and even take delight in, what is not naturally agreeable to any of his appetites; because when the choice is made, a relation is formed between the will and the object of choice, which, from being originally indifferent, now becomes a favourite object. But neither his Grace, nor any other asserter of human liberty, has ever affirmed or supposed, that any man or body of men could deliberately choose *evil* for its *own sake*, or enter zealously upon a tedious and difficult enterprise, from which *no good* could *possibly arise*, and from which *unmixed misery* was *clearly foreseen* as the *necessary result of every step of the progress*. Such, however, must have been the choice and the conduct of the apostles, when they resolved to preach a new religion founded on the resurrection of Jesus, if they did not certainly know that Jesus had risen from the dead. And this conduct must have been adopted, and, in opposition to every motive which can influence the human mind, have been persevered

‡ *Origin of Evil*, 4th edit. ch. v. sect. 1. subsect. 3. and 4.

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vered in by a great number of men and women, without the smallest contradiction having ever appeared in the various testimonies, which at different times, and under the cruellest tortures, they all gave to a variety of circumstances, of which not one had its foundation in truth. He who can admit this supposition, will not surely object to the incredibility of miracles. The resurrection of a man from the dead is an event so different indeed from the common course of things, that nothing but the most complete evidence can make it an object of rational belief; but as the resurrection of Jesus has always been said to have had God for its Author, it is an effect which does not exceed the power of the cause assigned, and is therefore an event possible in itself and capable of proof. It is a deviation from the laws of nature, but it is not contradictory to any one of those laws.

That a great number of men and women should deliberately form a plan of ruin and misery to themselves, without a prospect of the smallest advantage either in this world or in the next, is as different from the common course of things as the resurrection from the dead; and therefore in itself at least as great a miracle: but that they should persist in prosecuting this plan in the midst of torments; that they should spread themselves over the whole world, and everywhere publish a number of falsehoods, without any one of them contradicting the rest; that truth should never escape them either in an unguarded moment, or when lingering on the rack, and yet that all their lies should be in perfect agreement with each other; that they should every one of them court sufferings for a person whom they knew to be an impostor; that not one of the number—not even a single woman—should have so much compassion for a fellow-creature, as to rescue him from the flames by confessing a truth which could injure nobody—not even the suffering deceivers themselves;—all this is not only different from the common course of things, but directly contrary to the most known laws of nature, and is therefore not miraculous, but may be pronounced impossible. Yet this impossibility we must admit, or acknowledge, that as Christ died for our sins, according to the Scriptures, and was buried; so he arose again the third day according to the Scriptures; that he was seen of Cephas, then of the twelve; after that of above five hundred brethren at once; after that of James; then of all the apostles; and that he was last of all seen of St Paul *, who was converted by the vision to preach the faith which till then he had persecuted.

* 1 Cor. xv. 3—9.

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Hence we are assured of our own resurrection.

Thus we are assured, that "those who have fallen asleep in Christ are not lost, since he is risen from the dead, and become the first fruits of them that slept. For since by man came death, by man came also the resurrection of the dead. For as in Adam all die, even so in Christ shall all be made alive. But every man in his own order: Christ the first-fruits, afterwards they that are Christ's at his coming; for all that are in the graves shall hear his voice, and shall come forth; they that have done good unto the resurrection of life, and they that have done evil to the resurrection of damnation †."

† 1 Cor. xv. 20—24. and St John v. 28, 29.

Our blessed Lord having conversed familiarly with the eleven apostles for forty days after his resurrection, instructing them in the things pertaining to the kingdom of God; having extended their authority as his ministers, by giving them a commission to teach all nations, and make them his disciples, by baptizing them in the name of the Father, and of the Son, and of the Holy Ghost; and having promised them power from on high to enable them to discharge the duties of so laborious an office—led them on as far as Bethany, that they might be witnesses of his ascension into heaven. "When they therefore were come together, they asked of him, saying, Lord, wilt thou at this time restore again the kingdom to Israel? And he said, it is not for you to know the times and the seasons, which the Father hath put in his own power. But ye shall receive power after that the Holy Ghost is come upon you; and ye shall be witnesses unto me, both in Jerusalem, and in all Judea, and in Samaria, and unto the uttermost parts of the earth. But tarry ye in the city of Jerusalem, until ye be endued with power from on high; and he lift up his hands and blessed them; and it came to pass while he blessed them, he was parted from them, and a cloud received him out of their sight. And while they looked steadfastly towards heaven, as he went up, behold, two men stood by them in white apparel; who also said, Ye men of Galilee, why stand ye gazing up into heaven? This same Jesus, who is taken up from you into heaven, shall so come, in like manner as ye have seen him go into heaven. And they worshipped him, and returned to Jerusalem with great joy *."

* St Luke xxiv. 49—53. and Acts i. 6—12.

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Proofs of Christ's ascension.

That our blessed Lord ascended into heaven, will scarcely be denied in the present age by any one who admits that he rose from the dead. The ascension was indeed the natural consequence of the resurrection; for we cannot suppose that a man would be called back from the grave to live for ever in a world where all other men fall in succession a prey to death. The purpose for which he died was to recover for the descendants of Adam every privilege which they had forfeited through his transgression; and if, as has been generally believed, mankind were by the terms of the first covenant to enjoy eternal life in heaven, some proof was necessary that Christ by his death and resurrection had opened the kingdom of heaven to all faithful observers of the terms of the second. Hence it was prophesied † of the Messiah, in whom all the nations of the earth were to be blessed, that "he should ascend on high, lead captivity captive, and sit on the right hand of God until his enemies should be made his footstool." It was therefore of the greatest importance to the apostles to have sufficient proof of their Master's exaltation to the right hand of the Majesty on high; for otherwise they could neither have looked for an entrance into heaven themselves, by a new and living way, as the author of the epistle to the Hebrews expresses it, nor have preached Jesus as the Messiah promised to their fathers, since they could not have known that in him these prophecies were fulfilled. But the proof vouchsafed them was the most complete that the nature of the thing would bear. The spectators of the ascension were many; for, according to the history of St Luke ‡, those who returned from the Mount of Olives to Jerusalem, and prepared themselves for the coming of the Holy Ghost, were in number about six score; and to such a cloud of witnesses the evangelist would not have appealed, had not the fact he was recording been very generally known. Yet these were perhaps but part of the witnesses; for since

† Ps. lxviii. 18. cx. 1. Micah ii. 13.

‡ Acts i. 12—16.

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since Christ had told to his disciples that he was to ascend to his Father and their Father, to his God and their God, and that he was going to prepare a place for them, that where he is there they might be likewise; he can hardly doubt but that all who believed in him as the Redeemer of the world would take care to be present, not only to view their Master's triumph over all his enemies, but also to have a sight of that glory which awaited themselves. It was on this occasion probably that he was seen after his resurrection by above five hundred brethren at once, of whom the greater part were alive at the writing of St Paul's first epistle to the Corinthians.

But though such multitudes of people saw Jesus lifted up from the mount, and gradually vanish out of their sight, some other evidence seemed necessary to certify them of the place to which he had gone. Two angels therefore appear, and attest what human eyes could not see, but what was indeed the consequence of what they had seen. They attest that Christ had ascended to heaven, not to descend again till the last day; and surely, with respect to this point, the citizens of heaven were the most unexceptionable witnesses. We must therefore acknowledge and confess, against all the wild heresies of old (K), that Jesus Christ the Son of God, who died and rose again, did with the same body and soul with which he had lived upon earth ascend up "into heaven, there to appear in the presence of God for us *. Having in the outward tabernacle of this world once offered up himself a pure and perfect sacrifice for the expiation of our sins, he entered within the veil into the most holy place, there to present his blood before God himself, in order to obtain mercy for us, and restore us to the Divine favour. So that, "if any man sin, we have an advocate with the Father, Jesus Christ the righteous, who is the propitiation for our sins, and not for ours only, but also for the sins of the whole world; and he is able to save to the uttermost those that come to God by him, seeing he ever liveth to make intercession for us." "Seeing then that we have a great high-priest, who is passed into the heavens, Jesus the Son of God, we may through him come boldly unto the throne of grace, that we may obtain mercy and find grace to help him in time of need."

* Heb. ix. 24.

189 In heaven our Saviour executes the office of a priest,

190 and a king.

But it is not the office of a priest only that our Lord discharges in heaven; he is represented as sitting on the right hand of God, to denote that regal authority with which he is now vested; angels, and authorities, and powers, being made subject to him †." Hence it is, that after his resurrection, he said of himself ‡, "all power is given unto me in heaven and in earth;" for, as St Paul informs us §, "because he humbled himself and became obedient unto death, even the death of the cross, therefore God hath highly exalted him, and given him a name which is above every name: that at the name of Jesus every knee should bow, of things in heaven, and things in earth, and things under the earth." And this submission is due to him, because "God raised him from the dead, and set him at his own right hand in the heavenly places, far above all principalities and powers, and might, and dominion, and every name that is named, not only in this world, but also in that which is to come; and hath put all things under his feet, and gave him to be head over all things to the church *." As God, Christ possessed a kingdom, which, as it had not a beginning, can never have an end: but the dominion, of which the apostle is here treating, was conferred upon him as the mediator of the new covenant, and will no longer continue than till his enemies shall be subdued; for we are told, that "he must reign till he hath put all enemies under his feet; and that the last enemy which shall be destroyed is death." "He will ransom his subjects from the power of the grave; he will redeem them from death. O death, he will be thy plague; O grave, he will be thy destruction †." The trumpet shall sound, the graves shall be opened, all the sons and daughters of Adam shall return to life, and death shall be swallowed up in victory. "Then cometh the end, when the office of mediator ceasing, he shall have delivered up the kingdom to God, even the Father, when he shall have put down all rule and all authority and power. For when all things shall be subdued unto him, then shall the Son also himself be subject unto him that put all things under him, that God may be all in all ‡."

† 1 Peter iii. 22.

‡ Matth. xxviii. 18.

§ Phil. ii. 8, 9, 10.

* Eph. i. 20, &c.

† Hosea xiii. 14.

‡ 1 Cor. xv. 24—28.

191 Descent of the Holy Ghost on the apostles.

The first conspicuous proof which our blessed Lord gave of being vested with supreme power, and made head over all things to the church, was on the day of Pentecost. He had told the apostles that he would pray the Father to give them another comforter, who should abide with them for ever, even the Spirit of truth, which should teach them all things, and bring all things to their remembrance which he had said unto them. He had assured them, that it was expedient for them that he himself should go away; "for if I go not away (said he*), the Comforter will not come unto you; but if I depart, I will send him unto you." At his last interview with them, just before his ascension, he had desired them to tarry at Jerusalem till they should be endued with power from on high, before they entered upon their great work of converting the nations. These promises were amply fulfilled; for "when the day of Pentecost was fully come, they were all with one accord in one place. And suddenly there came a sound from heaven as of a rushing mighty wind, and it filled all the house where they were sitting. And there appeared unto them cloven tongues, like as of fire, and it sat upon each of them. And they were all filled with the Holy Ghost, and began to speak with other tongues, as the Spirit gave them utterance. And there were dwelling

* John xvi. 7.

(K) There was one Apelles in the primitive church, who was condemned as a heretic for teaching that Christ's body was dissolved in the air, and that he ascended to heaven without it. The opinions of this man and his followers are stated at large and confuted by Tertullian, Gregory Nazianzen, and Epiphanius; and the reader who thinks such ridiculous notions worthy his notice, will find enough said of them in the Notes to the sixth article of Pearson's Exposition of the Creed. Perhaps it may be from a hint communicated in these Notes, that our great modern corrector of the evangelists has discovered, if it be indeed true that he pretends to have discovered, that Jesus Christ is still upon earth.

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dwelling at Jerusalem Jews, devout men, out of every nation under heaven. Now when this was noised abroad, the multitude came together, and were confounded, because that every man heard them speak in his own language. And they were all amazed, and marvelled, saying one to another, Behold, are not all these who speak Galileans? And how hear we every man in our own tongue, wherein we were born? Parthians, and Medes, and Elamites, and the dwellers in Mesopotamia, and in Judea, and Cappadocia, in Pontus and Asia, Phrygia and Pamphylia, in Egypt and in the parts of Libya about Cyrene, and strangers of Rome, Jews, and proselytes, Cretes and Arabians—we do hear them speak in our tongues the wonderful works of God. And they were all amazed, and were in doubt, saying one to another, What meaneth this *!"

* Acts ii. 1—13.

192 Certainty of that miracle.

That those who heard the apostles speak so many different languages were amazed, is what we should naturally suppose; but that a single individual among them remained unconvinced, is astonishing; for the gift of tongues on the day of Pentecost is one of the most palpable miracles that was ever wrought. It is likewise one of the best authenticated miracles; for the book entitled *the Acts of the Apostles* was written not more than 30 years after the event took place (see SCRIPTURE, N° 168.); and it is not conceivable that, within so short a period, St Luke, or any man of common sense, would have appealed for the truth of what he recorded to so many inveterate enemies of the Christian name, had he not been aware that the miraculous gift of tongues was a fact incontrovertible. We all know how desirous the Jewish rulers were to stop the progress of the faith, by whatever means; but if this miracle was not really performed, they had now an opportunity of doing it effectually by means to which truth and honour would give their approbation. Thousands must have been alive in the city of Jerusalem who were men and women at the time when the apostles were said to have been thus suddenly inspired with the tongues of the Parthians, Medes, and Elamites, &c.; and as these foreigners were themselves either Jews by descent, or at least proselytes to the Jewish religion, surely the chief-priests would have found multitudes ready, both at home and abroad, to contradict this confident appeal of St Luke's if contradiction had been possible. We read however of no objection whatever being made to this miracle. Some of the audience, indeed, when the apostles addressed people of so many nations in all their respective languages, not understanding what was said, and taking it for jargon which had no meaning, concluded, not unnaturally, that the speakers were full of new wine, and mocked them for being drunk so early in the day; but this is a circumstance which, so far from rendering the miracle doubtful, adds much to the credit of the historian, as it would hardly have occurred to the writer of a narrative wholly false, and would certainly not have been mentioned, had he known that the apostles really attempted to impose on the multitude unmeaning sounds for foreign languages.

193 The gift of tongues permanent with the apostles.

As it is thus certain that the apostles were miraculously furnished with the gift of tongues, so the elegance and propriety of that miracle to attest the real descent of the Spirit of truth, who was to teach them all things, and endue them with power from on high to convert the nations, can never be enough admired by the pious Christian; for words being the vehicle of knowledge, an ability to speak the different languages of the earth was absolutely necessary to enable those who had been originally fishermen to go into all the world and preach the gospel to every creature. Yet there have been writers *, who, though unable to call in question the reality of the gift of tongues on the day of Pentecost, have contended, that it was a gift "not lasting, but instantaneous and transitory; not bestowed upon them for the constant work of the ministry, but as an occasional sign only, that the person endowed with it was a chosen minister of the gospel; which sign, according to them, ceased and totally vanished as soon as it had served that particular purpose." The chief argument upon which this opinion is attempted to be built, is drawn from the scripture Greek, which is said to be "utterly rude and barbarous, and abounding with every fault which can possibly deform a language; whereas we should naturally expect to find an inspired language pure, clear, noble, and affecting, even beyond the force of common speech; since nothing can come from God but what is perfect in its kind. In short, we should expect, says the objecter, the purity of Plato and the eloquence of Cicero †."

* Dr Middleton and Lord Shaftesbury.

194 Objections.

† Middleton's Essay on the Gift of Tongues.

In reply to this objection, it has been well observed ‡, that it supposes what is called the purity, elegance, and sublimity, of language, to be something natural and essential to human speech, and inherent in the constitution of things. "But the matter is far otherwise. These qualities are accidental and arbitrary, and depend on custom and fashion; modes of humanity as various as the different climes of the earth; and as inconstant as the tempers, genius, and circumstances, of its inhabitants. For what is *purity*, but the use of such terms and their combinations as the caprice of a writer or speaker of authority hath preferred to their equals? what is *elegance*, but such a turn of idiom as a fashionable fancy hath brought into credit; and what is *sublimity*, but the application of such images as arbitrary and casual connections, rather than their own native grandeur, have dignified and ennobled? The consequence of this is, that the mode of composition which is a model of perfection to one nation or people, has always appeared either extravagant or mean to another. Asiatic and Indian eloquence was esteemed hyperbolical and unnatural by the Greeks and Romans, and is so esteemed by us; whilst the Greek and Roman eloquence in its turn appeared cold and insipid to the warm inhabitants of the east; and ours would appear perhaps still colder. But the New Testament was designed for the rule of life to all mankind. Such a rule required inspiration; and inspiration, say the objectors, implies the most perfect eloquence. What human model then was the Holy Ghost to follow? for a human model it must have been, because there was no other; and if there had, no other would have answered the purpose, which was to make a due impression on the mind and affections. Should the eastern eloquence have been employed? But it would have been too swelling and animated for the west. Should the western? This would have been too still and inactive for the east. Or suppose us only solicitous for what we best understand; which species of this latter genus should the sacred writers have preferred? The dissolute softness of the Asiatic Greeks, or the dry conciseness of the Spartans? The flowing exuberances

‡ Warburton's Doctrine of Grace.

195 Answered.

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uberances of Attic eloquence, or the grave severity of the Roman?

"But are there not some general principles of eloquence in common to all the species? There are. Why then should not these have been employed to credit the apostolic inspiration? Because the end even of these (replies our author), is to mislead reason, and inflame the passions; which being abhorrent to the truth and purity of our holy religion, were very fitly rejected by the inspired penman. Besides, it might easily be known to have been the purpose of Providence, though such purpose had not been expressly declared, that the gospel should bear all possible marks of its divine original, as well in the course of its progress as in the circumstances of its promulgation. To this end, the human instruments of its conveyance were mean and illiterate, and chosen from among the lowest of the people, that when the world saw itself converted by the *foolishness of preaching*, as the only learned apostle thinks fit to call it, unbelievers might have no pretence to ascribe its success to the parts, or stations, or authority, of the preachers. Now had the language inspired into these illiterate men been the eloquence of Plato or Tully, Providence would have appeared to counteract its own measures, and to defeat the purpose best calculated to advance its glory. But God is wise, though man is a fool. The course of Providence was uniform and constant: It not only chose the weakest instruments, but carefully kept out of their hands that powerful weapon of WORDS which their adversaries might so easily have wrested to the dishonour of the gospel. Common sense tells us, that the style of an universal law should retain what is common to all languages, and neglect what is peculiar to each. It should retain nothing but CLEARNESS and PRECISION, by which the mind and sentiments of the writer are intelligibly conveyed to the reader. This quality is essential, invariably the same, and independent of custom and fashion. It is the consequence of syntax, the very thing in language which is least positive, as being formed on the principles of philosophy and logic: whereas all besides, from the very power of the elements and signification of the terms to the tropes and figures in composition, are arbitrary; and, as deviating from these principles, frequently vicious. But this quality of clearness and precision eminently distinguishes the writings of the New Testament; insomuch that it may be easily shown, that whatever difficulties occur in the sacred books do not arise from any imperfect information caused by this local or nominal barbarity of style; but either from the sublime or obscure nature of the things treated of, or from the intentional conciseness of the writers; who, in the casual mention of any thing not essential to the dispensation, always observe a studied brevity."

After much ingenious and sound reasoning on the nature of language in general, our author concludes, that the STYLE of the New Testament, even on the truth of what has been said to its discredit, is so far from proving the language not to be divinely inspired, that it bears one certain mark of that original. "Every language consists of two distinct parts, the single terms, and the phrases and idioms. Suppose now a foreign language to be instantaneously introduced into the minds of illiterate men like the apostles; the impression must be made either by fixing in the memory the terms and single words only with their signification, as, for instance, Greek words corresponding to such or such Syriac or Hebrew words; or else, together with that simple impression, by enriching the mind with all the phrases and idioms of the language so inspired. But to enrich the mind with the peculiar phrases and idiom of a foreign language, would require a previous impression to be made of the manners, notions, fashions, and opinions, of the people to whom that language is native; because the idiom and phrases arise from, and are dependent on, these manners. But this would be a waste of miracles without sufficient cause or occasion; for the Syriac or Hebrew idiom, to which the Jews were of themselves enabled to adapt the Greek or any other words, abundantly served the useful purposes of the gift of tongues, which all centered in those tongues, being so spoken and written as to be CLEARLY UNDERSTOOD. Hence it follows, that if the style of the New Testament were indeed derived from that language which was miraculously impressed upon the apostles on the day of Pentecost, it must be just such a one as in reality we find it to be; that is, it must consist of Greek words in the Syriac or Hebrew idiom."

196 Divinity of the Holy Ghost.

The immediate author of this gift, so necessary to the propagation of the gospel, was the Spirit of truth, or the Comforter, who is the Holy Ghost and the third person in the blessed Trinity. That there are three persons in the one Godhead, has been shewn at large in a former section of this article; and that the Holy Ghost is one of these three, might be safely concluded from the form of baptism instituted by Christ himself. But as more plausible objections have been urged against his divinity than any that we have met with against the divinity of Christ, it may not be improper to consider these before we proceed to give an account of the graces which he imparted to the infant church, and of the apostles preaching under his influence, By the Arians the Holy Ghost is considered as a creature; by the Socinians and modern Unitarians, as they call themselves, the words *Holy Ghost* are supposed to express, not a person or spiritual subsistence, but merely an energy or operation, a quality or power, of the Father, whom alone they acknowledge to be God. If this doctrine can be confuted, the Arian hypothesis will fall to the ground of itself; for it is not conceivable that any inspired teacher should command his followers to be baptized in the name of the self-existent God and two creatures.

197 Objections.

It is admitted by the Socinians themselves, that in the Scriptures many things are spoken of the Holy Ghost which can be properly predicated only of a person; but the inference drawn from this concession they endeavour to invalidate by observing, that in scripture there are likewise expressions in which things are predicated of abstract virtues, which can be literally true only of such persons as practise these virtues. Thus when St Paul says *, that "charity suffereth long and is kind, charity envieth not, charity vaunteth not itself, is not puffed up," &c. we cannot suppose his meaning to be, that these actions are performed by charity in the abstract, but that every charitable person, in consequence of that one Christian grace, suffereth long and is kind, envieth not, vaunteth not himself, and is not puffed up, &c. In like manner, say they, personal actions are attributed to the Holy Ghost, which itself is no

* 1 Cor. xiii. 4—8.

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no person, but only the virtue, power, or efficacy, of God the Father; because God the Father, who is a person, performs such actions by that power, virtue, or efficacy, in himself, which is denominated the Holy Ghost. Thus when we read * that "the Spirit said unto Peter, Behold three men seek thee; arise therefore and get thee down, and go with them, doubting nothing, for I have sent them;" we must understand that God the Father was the person who spoke these words and sent the three men; but because he did so by that virtue in him which is called the *Spirit*, therefore the *Spirit* is said to have spoken the words and sent the men. Again, when "the Holy Ghost said † to those at Antioch, Separate me Barnabas and Saul for the work whereunto I have called them;" we are to conceive that it was God the Father who commanded the two apostles to be separated for the work to which he had called them; but because he had done all this by that power within him which is called the Holy Ghost, therefore his words and actions are attributed to the Holy Ghost, just as long-suffering in men is attributed to charity.

* Acts x. 19, 20.

† Acts xiii. 2.

198 Answered.

This reasoning has a plausible appearance, and would be of much force were *all* the actions which in scripture are attributed to the Holy Ghost of such a nature as that they could be supposed to have proceeded from the person of God the Father in consequence of any particular power or virtue in him; but this is far from being the case. Thus "Spirit is said ‡ to make intercession for us;" but with whom can we suppose God the Father, the fountain of divinity, to intercede? Our Saviour assured § his disciples, that the Father would, in his name, send to them the Holy Ghost, who is the Comforter; that he would himself send the Comforter unto them from the Father; that the Comforter should not speak of himself, but speak only what he should hear; and that he should receive of Christ's, and shew it unto them. But we cannot, without blasphemy and absurdity, suppose that the Father would, in the name of Christ, send himself; that the Son would send the Father from the Father; and the Father would not speak of himself, but speak only what he heard; or that either the Father in person, or a quality of the Father, should receive any thing of Christ to shew unto the apostles.

‡ Rom. viii. 26. 27.

§ St John xiv. 26. xv. 26. xvi. 13, 14, 15.

The sagacity of Socinus perceived the force of such objections as these to his notion of the Holy Ghost being nothing more than the power of the Father personified; and therefore he invented another *prosopopeia* to serve his purpose in the interpretation of those texts to which this one cannot be applied. "The Spirit of God (says he ‖) may be considered either as a property or power in God, or as the things on which that power is working. When taken in the former sense, the Spirit, where any personal attribute is given to it, means God the Father; when taken in the latter sense, it means the man on whom the power of the Father is working; who, as long as he is affected by that power, is therefore called the Spirit of God;" and he quotes, we think most absurdly, the tenth verse of the second chapter of the first epistle to the Corinthians, as a text in which by the Spirit is meant an inspired man who could search all things, yea, even THE DEEP THINGS OF GOD.

‖ *Faust. Socinus in Resp. ad Wickam*, cap. 10.

How his modern followers, who deny the plenary inspiration even of Christ, will relish such a degree of inspiration as this, which raises mere men to a temporary equality with God, we know not; but leaving them to settle the dispute with their master, we shall produce one or two passages in which personal attributes are given to the Spirit of God, when it is impossible to conceive that Spirit, either as a power inherent in the Divine Father, or as the person on whom that power is operating. We need not bring new texts into view, as some of those already quoted will serve our purpose. When our Saviour promises that the *Holy Ghost*, *the Comforter*, *the Spirit of truth*, should be sent by the Father and the Son to the apostles, we have seen, that by this Spirit he could not mean the Father or a property of the Father; neither could he possibly mean the apostles themselves, unless we are to suppose that the Father and the Son sent St Peter to St Peter, and that St Peter, so sent, came to St Peter! Again, when Christ saith of the Holy Ghost, "he shall receive of mine, and shall show it unto you," he could not, for the reason already assigned, mean by the Holy Ghost the Father or the power of the Father; and surely his meaning was not, that the apostles, under the influence of the power of the Father, should receive something and shew it each to himself! The Holy Ghost therefore is unquestionably a person; for though there are many passages of scripture in which the *gifts* of the Holy Ghost are called the *Holy Ghost*, they are so called by a very common figure of speech, in which the effect receives the name of its cause: and since this person is joined with the Father and the Son in the formula of Christian baptism; since they who lied to the Holy Ghost are said * to have lied unto God; since blasphemy against him is a more heinous offence than the same sin against even the Father or the Son †; and since it was by the operation of the Holy Ghost that Jesus Christ was conceived of the Virgin Mary, and even on that account called the ‡ Son of God—it follows that the Holy Ghost is God, of the same substance with the Father and Son.

* Acts v. 4.

† Mark iii. 28, 29.

‡ Luke i. 35.

199 The apostles miraculously instructed in the principles of religion.

It was this Divine Spirit which, on the day of Pentecost, inspired the apostles with the knowledge of different languages; and as these were given only to enable them to preach the gospel to every creature, it can admit of no doubt but that he, who so amply provided the means of preaching, would take care that the gospel should be preached in purity. Our Saviour had told his apostles, that the Comforter would guide them into all the truth (εις πασαν την αληθειαν), and bring all things to their remembrance, whatsoever he had said unto them; but if they had not comprehended the meaning of what he said, the bare remembrance of his sayings would have been of little importance. That before this miraculous shedding abroad of the Spirit they had but a very imperfect knowledge of his doctrines, and of the purpose for which he had come into the world, is apparent from that unseasonable question which they put to him when assembled to witness his glorious ascension; "Lord, wilt thou at this time restore again the kingdom to Israel?"

200 Their great need of such instruction.

Their minds still cherished with fondness the vain prospect of temporal power; but after the day of Pentecost they were directed to nobler objects. From the same Spirit they received diversities of gifts besides that of language; for we are assured by St Paul §, when speaking of the early converts to Christianity in general,

§ 1 Cor. xii. 8—12.

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ral, that "to one was given by the Spirit the word of WISDOM; to another the word of KNOWLEDGE by the same Spirit; to another FAITH by the same Spirit; to another the gifts of HEALING by the same Spirit; to another the working of MIRACLES; to another PROPHECY; to another DISCERNING OF SPIRITS; to another DIVERS KINDS of TONGUES; to another the INTERPRETATION OF TONGUES:" and these gifts, which were severally divided either among private Christians or among the inferior orders of ministers in the church, we have reason to believe were all bestowed in a greater or less degree upon each of the apostles.

Men thus endowed were well qualified to declare unto the world all the counsel of God. By the word of *wisdom* they communicated to the Gentile nations a pure system of what is called *natural religion;* turning them from the vanity of idols to the worship of the living God: by the word of *knowledge*, they preached the great doctrines of revelation both to Jews and Gentiles, shewing them that there is none other name under heaven given unto men whereby they may be saved than the name of Jesus Christ (L); and by their gifts of *healing* and of *miracles*, &c.; they were enabled to prove unanswerably, that their doctrines were divine. They taught everywhere the unity of God, the creation of the world, the fall of man, the necessity of redemption, the divinity of the Redeemer, his sacrifice on the cross to restore mankind to their forfeited immortality, and the terms of the new covenant into which they had through him been graciously admitted by God.

Such a view as our limits would admit of we have given of all these doctrines, except that which respects the terms of the gospel covenant; but these being explicitly stated only by St Paul and St James, we could not till now investigate them, without violating the historical order into which, for the sake of perspicuity, we have digested the several parts of this short system. Our Saviour himself has indeed taught with great plainness the necessity of faith and baptism to the salvation of those who have an opportunity of hearing the gospel preached with power (see BAPTISM): and in his sermon on the mount, which is such a lecture of ethics founded on religion as the Son of God only could have delivered, we learn, that "unless our righteousness shall exceed the righteousness of the Scribes and Pharisees, we shall in no case enter into the kingdom of heaven; that not every one who saith unto Christ, Lord, Lord, shall enter into the kingdom of heaven, but he who doth the will of the Father who is in heaven: and that many will say to him at the day of judgment, Lord, Lord, have we not prophesied in thy name, and in thy name done many wonderful works?" which could not be done without faith; to whom he will, notwithstanding, say, "Depart from me, ye that work iniquity *." St Paul, however, seems to attribute our justification to the bare act of believing; for he repeatedly assures us, "that a man is justified by faith without the deeds of the law;" while St James, on the other hand, affirms, "that by works a man is justified, and not by faith only." This apparent difference in the language of the two apostles, has produced among divines opinions really different respecting the justification of Christians; and the principal of these opinions it is our duty to state.

* St Matt. v. 20. vii. 21.—24.

201
Meaning of justification.

Between *pardon* of sin and *justification* there is so close a connection, that many writers seem to consider the terms as synonymous, and to infer, that he who is pardoned is *ipso facto* justified. That every Christian, who shall be pardoned at the judgment of the great day, will likewise be justified, is indeed true; but in propriety of speech, *justification* is a word of very different import from *pardon*, and will entitle the Christian to what mere pardon could not lead him to expect. An innocent person, when falsely accused and acquitted, is *justified* but not *pardoned;* and a criminal may be *pardoned*, though he cannot be *justified* or declared innocent. A man whose sins are pardoned is free from punishment; but the justified Christian is entitled to everlasting life, happiness, and glory. If we were only pardoned through Christ, we should indeed escape the pains of hell, but could have no claim to the enjoyments of heaven; for these, being more than the most perfect human virtue can merit, must be, what in the scriptures they are always said to be, "the gift of God through Jesus Christ our Lord." Hence it is that St Paul, distinguishing, as we have done upon his authority, between mere remission of sins and justification of life, declares †, that "Jesus our Lord was *delivered* for our *offences*, and *raised* again for our *justification*."

† Romans iv. 25.

The word justification, as used both by St Paul and St James, has been very generally considered as a forensic term expressing the sentence of a judge. The most eminent reformed divines of all denominations ‡, and even many of the Romanists themselves, have strenuously contended, that this is its genuine sense, when it is distinguished from mere remission of sins, regeneration, and sanctification; and if so, it will signify God's pronouncing a person *just*, either as being perfectly blameless, or as having fulfilled certain conditions required of him in the Christian covenant. But that "there is not a just man upon earth, who doth good and sinneth not," is made known to us by the most complete evidence possible, the joint dictates of our own consciences and of divine

‡ *Limborch, Bull, Waterland, Warburton, Beveridge, Vitringa, Gill*, &c.

(L) It is not perhaps easy to determine what is here meant by the word of WISDOM and the word of KNOWLEDGE, as distinguished from each other. By the former (λογος σοφιας), Bishop Warburton understands all the great principles of natural religion. "The ancients (says he) used the word σοφια in this peculiar sense; it is used in the same sense by St Paul in Col. iv. 5.; and we can hardly give it any other in the place before us, where we see the word of wisdom distinguished from the word of knowledge (λογος γνωσεως), which evidently means all the great principles of revelation; the term γνωσις being as peculiarly applied by Christian writers to revealed religion as σοφια is by the Gentiles to the natural. St Paul uses the word in this sense in 2 Cor. xi. 6. where he says, Ει δε και ιδιωτης τω λογω αλλου τη γνωσει; and St Peter in his first epistle, chap. iii. verse 7. Hence those early heretics who so much deformed the simplicity and purity of the Christian faith by visionary pretences to superior knowledge of revelation, took from this word the name of Gnostics." See *Warburton's Sermon on the Office and Operation of the Holy Ghost*.

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divine revelation; and therefore whosoever is pronounced just by the Judge of all the earth, must be so, either because, though not absolutely blameless, he has performed the conditions required of him in the covenant of grace, or because Christ has fulfilled all righteousness in his stead.

202 It is a forensic term.

If this be the Scripture notion of justification, it must be wholly the act of God, and cannot be the effect either of our faith or of our virtue. Accordingly, we are said by the apostle to be justified freely by his grace through the redemption that is in Jesus Christ; whom *God hath set forth* to be a propitiation through faith in his blood *. The act of justification therefore proceeds from the divine philanthropy, and cannot be performed by the instrumentality of faith; for it is not God, but man, who believes; and man is not the justifier of himself. To talk of any kind of *instrument* of justification besides the propitiation set forth by God, is indeed to make use of very improper language: "Omnis causa instrumentalis (says Bishop Bull †), suo modo in effectum influit, eique effecti productio propriè attribui potest. Jam vero, cum justificatio nihil aliud sit quam gratiosus Dei actus, quo peccata nostra nobis condonet, ac nos ad salutem acceptet, valde absurdum esset dicere, vel fidem, vel opera nostra, vel quidvis aliud, nostri aut remittere peccata nostra, aut personas nostras acceptare: quod tamen, si instrumentalis causa justificationis fides sit, planè dicendum esset."

* Rom. iii. 24, 25.

† *Harmonia Apostolica*, cap. ii. § 9.

In this sentiment of the bishop of St David's some of the most eminent divines both among the Calvinists and Arminians agree. Many, however, have chosen to treat of justification not only in the active sense, as it is the act of God, for all admit that it is he who justifies; but likewise in a passive sense, as it means our *privilege* or *possession* holden of him, when we are said to be justified by his grace. In this view of the subject they may talk with sufficient propriety, of an instrument of justification, not as the mean by which it is conveyed, but as the medium through which it is received by the true Christian. And hence it follows, that Waterland and Warburton strenuously maintain the doctrine of the Westminster Confession, "that faith receiving and resting on Christ is the alone instrument of justification; though it cannot be alone in the person justified, but must ever be accompanied with all other saving graces, and be a faith which worketh by love."

But notwithstanding this agreement between the leaders of the rival sects, they have found abundant matter of controversy respecting faith and works, in deciding the great question, "Whether, when God justifies man, he considers him as absolutely righteous on account of Christ's righteousness performed in his stead; or only as just, because he has fulfiled the conditions of the covenant of grace, which does not require of him perfect righteousness?" The former is the doctrine of the more rigid Calvinists, the latter that of the Arminians or Remonstrants.

"A notion (says Dr Gill ‡) obtained some years ago, that a relaxation of the law and the severities of it has been obtained by Christ; and a new law, a remedial law, a law of milder terms, been introduced by him, which is the gospel; the terms of which are, faith, repentance, and new obedience; and though these be imperfect, yet, being sincere, they are accepted by God in the room of perfect righteousness. But every article of this scheme (continues he) is wrong; for the law is not relaxed, nor any of its severities abated; Christ came not to destroy, but to fulfil it; and therefore it requires the same holy, just, and good things, as ever. Nor is the gospel a new law. There is nothing in it (he says) which looks like a law; for it has no commands in it, but all promises, being a pure declaration of grace and salvation by Christ; nor are faith, repentance, and a new obedience, required by it as conditions of man's acceptance with God. Faith and repentance are gospel doctrines, and parts of the gospel ministry; they are graces, and not terms required to be performed by men of themselves. Faith is the gift of God, and repentance is a grant from him. It is not true (continues our author) that God will accept of an imperfect righteousness in the room of a perfect one; nor can any thing more highly reflect upon the justice and truth of God, who is the judge of all the earth, than to suppose that he can ever account that as a righteousness which is not one."

‡ *Body of Divinity*, vol. ii. book iii. chap. 8. § 5.

203 Doctrine of the Calvinists respecting it.

Having thus proved by arguments which were almost in the same words stated long before by Bishop Beveridge *, that the gospel is no relaxation of the law, he proceeds to lay down his own notions of justification, of which (he says) "the sole matter, or that for the sake of which a sinner is justified before God, is the righteousness of Christ—that which he did and suffered on earth, in our nature, in our stead, and as our representative. This is commonly called his active and passive obedience; and when the purity and holiness of his own nature was added to it, the whole made up the δικαιωμα του νομου, *the righteousness of the law*, which was fulfilled by him as the head and representative of his people †; for whatever the law required is necessary to a sinner's justification before God, and it required of sinners more than it did of man in innocence. Man was created with a pure and holy nature, conformable to the pure and holy law of God; and it was incumbent on him to continue so, and to yield in it perfect and sinless obedience, in the failure whereof he was threatened with death. Man did fail, by which his nature was vitiated and corrupted, and his obedience became faulty and imperfect. He therefore became liable to the penalty of the law, and still perfect obedience was required him. To the justification of a sinner therefore is required the most complete obedience, active and passive; or, in other words, purity of nature, perfect obedience, and the sufferings of death; all which meet in Christ, the representative of his people, in whom they are justified. There are indeed some divines (continues our author) who exclude the active obedience of Christ from being any part of the righteousness by which men are justified. They allow it to have been a condition requisite in him as a Mediator, qualifying him for his office; but deny that it is the matter of justification, or reckoned for righteousness to man. But without the active obedience of Christ the law would not be satisfied; the language of which is, *Do and live;* and unless its precepts be obeyed, as well as its penalty endured, it cannot be satisfied; and unless it be satisfied there can be no justification. If therefore men are justified by the righteousness of Christ, it must be by his active obedience imputed and made over to them, so as to become their's, *even as David describeth the blessedness of the man unto whom God imputeth righteousness without works* ‡. That this is really the way in which men are justified, our author thinks evident,

* See his *Private Thoughts of Religion*.

† Rom. viii. 4.

‡ Rom. iv. 6.

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evident, because they must be justified either by an inherent or by an imputed righteousness; but they cannot be justified by their own inherent righteousness, for that is imperfect, and therefore not justifying. Hence the apostle 'counts all things but dung, that he may win Christ and be found in him; not having his own righteousness, which is of the law, but that which is *through the faith of Christ*, the righteousness which is of *God by faith* *.' But by such a righteousness as this a man cannot be justified in any other way than by an imputation of it to him. Whence it follows, that '*as by one man's disobedience many were made sinners* by imputation, so *by the obedience of one shall many be made* righteous, by having that obedience placed to their own account."

* Philip. iii. 8, 9.

As this author properly considers justification as the act of God, he does not approve of the language in which faith is called the instrument either of conferring or receiving it. "Faith (says he †) is merely the evidence of justification to the person justified; for 'faith is the evidence of things not seen.' The righteousness of God, of the God-man and Mediator Jesus Christ, is revealed from faith to faith in the everlasting gospel ‡; and therefore must be before it is revealed, and before the faith to which it is revealed. Faith is that grace whereby a soul, having seen its want of righteousness, beholds in the light of the Divine Spirit a complete righteousness in Christ, renounces its own, lays hold on that, puts it on as a garment, rejoices in it, and glories of it; the Spirit of God witnessing to his spirit that he is a justified person: and so he is evidently and declaratively 'justified in the name of the Lord Jesus, and by the spirit of our God ‖'. Faith adds nothing to the *esse*, only to the *bene esse* of justification; which is a complete act in the eternal mind of God, without the being or consideration of faith, or any foresight of it. In the account of God, a man is as much justified before his faith as after it; and after he does believe, his justification depends not on his acts of faith, for though *we believe not, yet God abides faithful* to his covenant-engagements with his Son, by whose suretyship-righteousness the elect are justified; but by faith men have a comfortable sense, perception, and apprehension, of their justification, and enjoy that peace of soul which results from it. It is by that only, under the testimony of the Divine Spirit, that they know their interest in it, and can claim it, and so have the comfort of it."

† *Body of Divinity*, vol. i. book ii. § 5.

‡ Rom. i. 17.

‖ 1 Cor. vi. 11.

Though this language differs from that of the Westminster Confession, the author seems not to teach a different doctrine; for if faith be that grace by which a soul renounces its own righteousness, and lays hold of Christ's, which it puts on as a garment, it must be that very thing which the compilers of the Confession meant by their definition of faith receiving and resting on Christ and his righteousness, when they called it "the alone instrument of justification." Accordingly our author elsewhere * teaches, that "true faith in sensible sinners assents to Christ and embraces him, not merely as a Saviour of man in general, but as a special suitable Saviour for them in particular. It proceeds upon Christ's being revealed *in* them as well as *to* them, by the spirit of wisdom and revelation, in the knowledge of him as a Saviour that becomes them. It comes not merely through external teachings by the hearing of the word from men; for no man, saith our blessed Lord, can come to me except the Father draw him; but such souls as are thus drawn, having heard and learned of the Father, believe not only in the *doctrine* of Christ, but also in *himself*, trusting in him alone for everlasting life and salvation."

* *Body of Practical Divinity*, book i. chap. 6.

204 And of the more moderate Arminians.

Were it not that this author, in every thing that he writes, has an eye to the doctrine of election and reprobation, which he carries to a greater height than almost any other divine with whose works we are acquainted, he would differ little in his notions of justification from the more moderate Arminians. "Justification (says Limborch) is the merciful and gracious act of God, whereby he fully absolves from all guilt the truly penitent and believing soul, through, and for the sake of Christ apprehended by a true faith; or gratuitously remits sins upon the account of faith in Jesus Christ, and graciously imputes that faith for righteousness." Here indeed the imputation of Christ's righteousness is expressly denied; but Dr Waterland, who can hardly be considered as a Calvinist, seems to contend for the imputation of that righteousness to the sinner, as well as for faith being the instrument by which it is received.

"It cannot be for nothing (says that able writer *) that St Paul so often and so emphatically speaks of man's being justified by faith, or through faith in Christ's blood; and that he particularly notes it of Abraham, that he *believed*, and that his faith was counted to him for justification, when he might as easily have said that Abraham, to whom the gospel was preached, was justified by gospel-faith and obedience, had he thought faith and obedience equally instruments of justification. Besides, it is on all hands allowed, that though St Paul did not directly oppose faith to *evangelical works*, yet he comprehended the works of the *moral law* under those which he excluded from the office of *justifying*, in his sense of the word justification. He even used such arguments as extended to all kinds of works; for Abraham's works were excluded, though they were undoubtedly evangelical. To prove that he interprets the apostle's doctrine fairly, our author quotes, from the genuine epistle of Clemens of Rome, a passage, in which it appears beyond a doubt that this fellow-labourer of St Paul so understood the doctrine of justifying faith as to oppose it even to evangelical works, however exalted. It is true (continues our author), Clemens elsewhere, and St Paul almost everywhere, insists upon true holiness of heart and obedience of life as indispensable conditions of salvation or justification; and of that, one would think, there could be no question among men of any judgment or probity. But the question about conditions is very distinct from the other question about instruments; and therefore both parts may be true, viz. that faith and obedience are equally conditions, and equally indispensable where opportunities permit; and yet faith over and above is emphatically the instrument both of receiving and holding justification, or a title to salvation.

* *Summary View of Justification.*

205 Faith the instrument of it.

"To explain this matter more distinctly, let it be remembered, that God may be considered either as a party contracting with man on very gracious terms, or as a Judge to pronounce sentence on him. Man can enter into the covenant, supposing him adult, only by assenting to it; and accepting it, to have and to hold it on such kind of tenure as God proposes: that is to say, upon a self-denying tenure, considering himself as a guilty man standing in need of pardon, and of borrowed merits, and at length resting upon mercy. So here, the previous question is, Whether a person shall consent to hold a privilege upon this submissive kind of tenure or not?

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not? Such assent or consent, if he comes into it, is the very thing which St Paul and St Clemens call *faith*. And this previous and general question is the question which both of them determine against any proud claimants who would hold by a more self admiring tenure.

"Or if we next consider God as sitting in judgment, and man before the tribunal going to plead his cause; here the question is, What kind of plea shall a man resolve to trust his salvation upon? Shall he stand upon his innocence, and rest upon strict law? or shall he plead guilty, and rest in an act of grace? If he chooses the former, he is proud, and sure to be cast: if he chooses the latter, he is safe so far in throwing himself upon an act of grace. Now this question also, which St Paul has decided, is previous to the question, What conditions even the act of grace itself finally insists upon? A question which St James in particular, and the general tenure of the whole Scripture, has abundantly satisfied; and which could never have been made a question by any considerate or impartial Christian. None of our works are good enough to stand by themselves before him who is of purer eyes than to behold iniquity. Christ only is pure enough for it at first hand, and they that are Christ's at second hand in and through him. Now because it is by faith that we thus interpose, as it were, Christ between God and us, in order to gain acceptance by him; therefore faith is emphatically the instrument whereby we receive the grant of justification. Obedience is equally a condition or qualification, but not an instrument, not being that act of the mind whereby we look up to God and Christ, and whereby we embrace the promises."

206
Faith and obedience its conditions.

But though our author contends that faith is the instrument of justification, he does not, like the Antinomians, teach that it will save men without works. "The covenant of grace (says he) has conditions annexed to it of great importance, for without them no instruments can avail. These are faith and obedience, as St James hath particularly maintained. St Paul had before determined the general and previous question respecting the plea by which we ought to abide; and when some libertines, as is probable, had perverted his doctrine of faith and grace, St James showed that the very faith which rests in a covenant of grace implies a cordial submission to the conditions of that covenant, otherwise it would be nothing but an empty ceremony. The perfect agreement between St Paul and St James in the article of *justification*, appears very clear and certain. St Paul declares, that in order to come at justification, it is necessary to stand upon grace, not upon merit; which St James does not deny, but rather confirms, in what he says of the perfect law of liberty (James i. 25. ii. 12.). St Paul makes faith the instrument of receiving that grace; which St James does not dispute, but approves by what he says of Abraham (ii. 23.); only he maintains also, that in the conditionate sense, justification depends equally upon faith and good works; which St Paul also teaches and inculcates in effect, or, in other words, through all his writings. If St Paul had had precisely the same question before him which St James happened to have, he would have decided just as St James did; and if St James had had precisely the same question before him which St Paul had, he would have determined just as St Paul did. Their principles were exactly the same, but the questions were diverse; and they had different adversaries to deal with, and opposite extremes to encounter, which is a common case.

"It may be noted, that that faith which is here called a *condition*, is of much wider compass than that particular kind of faith which is precisely the instrument of justification. For faith as a condition means the whole complex of Christian belief, as expressed in the creeds; while faith as an instrument means only the laying hold on grace, and resting in Christ's merits, in opposition to our own deservings: though this also, if it is a vital and operative principle (and if it is not, it is nothing worth), must of course draw after it an hearty submission to, and observance of, all the necessary conditions of that covenant of grace wherein we repose our whole trust and confidence. So that St Paul might well say, "Do we then make void the law (the moral law) through faith? God forbid, Yea, we establish the law *." We exempt no man from religious duties; which are duties still, though they do not merit nor are practicable to such a degree as to be above the need of pardon: they are necessary conditions in their measure of justification, though not sufficient in themselves to justify, nor perfect enough to stand before God or to abide trial: therefore Christ's merits must be taken to supply their defects: and so our resting in Christ's atonement by an humble self-denying faith is our last resort, our anchor of salvation both sure and steadfast, after we have otherwise done our utmost towards the fulfilling of God's sacred laws, towards the performing of all the conditions required.

* Rom. iii. 31.

"That good works, internal and external, are according as opportunities offer and circumstances permit, *conditions* properly so called, is clear from the whole tenor of Scripture, as hath been often and abundantly proved by our own divines (M), and is admitted by the most judicious among the foreign Reformed (N). Yet some have been very scrupulous as to this innocent name, even while they allow the absolute necessity of good works as indispensable qualifications for future blessedness. Why not conditions therefore as well as qualifications? Perhaps because that name might appear to strike at absolute predestination, or unconditional election; and there may lie the scruple: otherwise the difference appears to lie rather in words than in things.

"Some will have them called not conditions, but *fruits* or *consequents* of justification. If they mean by justification the same as the grace of the Holy Spirit, and the first grace of faith springing from it, they say true; and then there is nothing more in it than an improper use of the word *justification*, except that from abuse of words very frequently arises some corruption of doctrine. If they mean only, that outward acts of righteousness are fruits of inward habits or dispositions; that

(M) Bull. *Op. Latin.* p. 412, 414, 415, 430, 434, 514, 516, 544, 583, 645, 668. *Edit. ult.*—Stillingfleet's Works, vol. iii. p. 367, 380, 393, 398.—Tillotson's Posthumous Sermons, vol. ii. p. 484, 487.

(N) Vossius *de Bonis Operibus*, Thes. x. p. 370.—Op. tom. vi.—*Frid. Spanhem. fil.* Op. tom. iii. p. 141, 159.

that also is undoubtedly true: but that is no reason why internal acts, virtues, graces (good works of the mind), should not be called conditions of justification; or why the outward acts should not be justly thought conditions of preserving it. But if they mean that justification is ordinarily given to adults, without any preparative or previous conditions of faith and repentance, that indeed is very new doctrine and dangerous, and opens a wide door to carnal security and to all ungodliness."

Such is the doctrine of Christian justification as it has been taught by the followers of Calvin, and by some of the most eminent Arminians who flourished in the end of the 17th and beginning of the 18th century. They appear not, from this view of their opinions, to differ so widely as some of them have wished the world to believe. It is evident that Dr Waterland, though he rejects some of the distinguishing tenets of Calvinism, lays greater stress upon faith in his scheme of justification than Dr Gill himself; and that they both consider it as the *instrument* by which the adult Christian must

207 Objections of the more zealous Arminians to this statement of the doctrine.

receive the imputed righteousness of Christ. The greater part of modern Arminians, however, exclaim against the imputation of Christ's righteousness, as a doctrine false in itself, and fraught with the most pernicious consequences; and they would be ready to tell Dr Gill, in his own words, that of his scheme every article is wrong. It is not true (say they) that God exacts of man, or ever did exact of him, an obedience absolutely perfect; for under every dispensation man was in a state of discipline, and had habits of virtue and piety to acquire; and it is probable that his progress in piety, virtue, and wisdom, will continue for ever, as none but God is perfect and stationary, and incapable of deviating from the line of rectitude. Most of them, after Bishop Bull, dislike the use of such unscriptural phrases as *instrument of justification*, applied either to faith or to works; and think, that by considering God as the sole justifier of man, upon certain conditions, they can more precisely ascertain the distinct provinces of faith and obedience in the scheme of justification, than either their brethren of the old school of Arminius, or their rivals of the school of Calvin.

208 Their own statement of it.

By the very constitution of man, piety and virtue are duties which, if he do not sincerely perform, he must of course forfeit the favour of his Maker; but the most perfect performance of his natural duties would not entitle him to a supernatural and eternal reward. Eternal life is the *gift* of God through Jesus Christ; and it is surely reasonable that we should acknowledge it to be so, and not claim it as a debt due to our merits. The pious and virtuous man has a natural claim to more happiness than misery during the period of his existence, a claim founded on the attributes of that God who called him into being; but he has no natural claim to a future life, and still less to a perpetuity of existence. This is a truth not more clearly taught in the holy scripture than consonant to the soundest philosophy: and yet, by not attending to it, have St Paul and St James been set at variance, and the most opposite doctrines taught respecting the justification of Christians.

Because faith in Christ cannot entitle a wicked man to eternal *happiness*, one class of divines seem to infer that such faith is not necessary to Christian *justification*, and that "his faith cannot be wrong whose life is in the right." They proceed upon the supposition that man is naturally immoral; that piety and virtue are entitled to reward; and that therefore the pious and virtuous man, whatever be his belief, must undoubtedly inherit an eternal reward. But this is very fallacious reasoning. That piety and virtue are through the divine justice and benevolence entitled to reward, is indeed a truth incontrovertible; but that man who is of yesterday is naturally immortal; that a being who began to exist by the mere good will of his Maker, has in himself a principle of perpetual existence independent of that will—is a direct contradiction. Whatever began to be, can be continued in being only by the power, and according to the pleasure, of the infinite Creator; but it pleased the Creator of his free grace at first to promise mankind eternal life, on the single condition of their first father's observing one positive precept. That precept was violated, and the free gift lost: but the co-

209 Faith the sole condition of the justification peculiarly Christian;

venant was renewed in Christ, who "by his death hath abolished death, and by his resurrection hath brought to light life and immortality." The condition annexed to the gift thus restored was faith; for "being justified by faith *, we have peace with God through our Lord Jesus Christ; by whom also we have access by faith into this grace wherein we stand, and rejoice in the hope of the GLORY OF GOD." Faith therefore in the Son of God and Saviour of the world, is not only a condition, but the *sole* condition, of that justification which is peculiarly Christian; for since Christ, without any co-operation of ours, hath purchased for us the free gift of eternal life, we shall be guilty of the grossest ingratitude to our Divine Benefactor, and impiously claim an independence on God, if we look upon that gift either as a right inherent in our nature, or as a debt due to our meritorious deeds.

* Rom. v. 1, 2.

210 but not of obtaining eternal happiness.

But though faith be the condition of justification, as that implies the inheritance of *eternal life*, there are other conditions to be performed before a man can be put in possession of *eternal felicity*. By a law long prior to the promulgation of the gospel—a law interwoven with our very being—no man can enjoy the favour of his Maker, who does not make it his constant endeavour "to do justly, to love mercy, and to walk humbly with his God." This law was in force before man fell; it continues to be in force now that he is redeemed; and it will not be abrogated even at that period when faith shall give place to vision, and hope to enjoyment.

211 The different conditions of divine favour and of eternal life.

By the grace of the Christian covenant, all mankind are rendered immortal in consequence of the death and resurrection of Christ, who is the Lamb slain, in the divine decree, from the foundation of the world; but to obtain immortal *happiness*, they must observe the conditions both of nature and of revealed religion, which are repentance from dead works, and faith in Christ the Redeemer. The former is that condition upon which alone we can retain the Divine favour, and of course enjoy either present or future happiness; the latter is a most equitable acknowledgement required of us, that perpetual conscious existence is neither a right inherent in our nature, nor a debt due to our virtuous obedience, but merely the gift of God through Jesus Christ our Lord.

"To make the distinct provinces of faith and works in the business of justification clear, let us suppose (says Bishop Warburton †), that, at the publication of the gospel, all to whom the glad tidings of immortality were

† Div. Leg. book ix. chap. 3.

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were offered on the condition of *faith in Jesus* had been moral or virtuous men, and on that account entitled (as natural religion teacheth) to the favour of God and an abundant reward; is it not self-evident that FAITH ALONE, exclusive of the condition of good works, would, in that case, have been the very thing which *justified* or entitled them to life *everlasting*? But are *good works*, therefore, of no use in the Christian system? So far from it, that those only who serve God in sincerity and in truth are capable of the justification which faith alone

212 Illustrated by a familiar example.

embraces; for, to illustrate this matter by a familiar instance, suppose a British monarch to bestow, in *free gift*, a certain portion of his own *domains*, to which immortality may well be compared, upon such of his subjects as should perform a certain service to which they were not obliged by the laws of the kingdom; it is evident that the performance of this last service ONLY would be the thing which entitled them to the *free gift*. Yet it is obvious that obedience to the laws, which gave them a claim to protection as subjects, in the enjoyment OF THEIR OWN PROPERTY (to which the reward offered by natural religion may be compared), would be a previous and necessary qualification to their enjoyment of their new possession; since it is absurd to suppose that such a *gift* could be intended for rebels and traitors, or indeed for any but good and faithful servants of their king and country." Well therefore might the apostle reprove the ignorance or licentiousness of certain of his converts at Rome, in his question—"Do we then make void the LAW through FAITH? God forbid! yea, we ESTABLISH THE LAW;" obedience to it being the previous qualification of all who are entitled to the fruits of justifying faith—LIFE AND IMMORTALITY.

Had proper attention been paid to this distinction, which St Paul everywhere makes between such duties as are common to all religions that are true, and those which are peculiar to the Christian revelation, many useless controversies might have been avoided respecting the instrument of justification and the conditions of the Christian covenant. By not attending to it, the divines of one school, who perceive that the mere belief of any truth whatever cannot entitle a man to eternal felicity, have almost dropt faith from their system of Christianity, and taught moral duties like Pagan philosophers; whilst another party, who err almost as far in their interpretations of scripture, finding eternal life represented as the *gift of God*, and faith in Christ as the instrument

213 Sum of Christianity.

or means by which that gift must be accepted, have expunged from their system the necessity of good works, forgetting surely that wicked believers, like believing devils, may be doomed to an eternity of torments. But the sum of Christianity, as we are taught by the beloved disciple, is comprehended in this one commandment of God, "that we should believe on the name of his Son Jesus Christ, and love one another as he gave us commandment." In perfect harmony with him, the great apostle of the Gentiles assures us*, that "in Christ Jesus nothing can avail to our eternal happiness but faith which WORKETH BY LOVE;" and he informs Titus†, that it "is a true saying, and what he wills to be constantly affirmed, that they who have believed in God be careful to maintain good works."

* Gal. v. 6.

† Chap. iii. 8.

Indeed no man can have complete faith in Christ who believes not the promises of the gospel; but all those promises, except the single one of resurrection from the dead to perpetual conscious existence, are made to us upon the express condition that we obey the law of the gospel; "for God will render to every man according to his deeds: to them that are contentious and do not obey the truth, but obey unrighteousness, indignation and wrath; tribulation and anguish upon every soul of man that doth evil, of the Jew first and also of the Gentile; but glory, honour, and peace to every man that worketh good, to the Jew first and also to the Gentile*."

* Rom. ii. 8, 9.

Such are the notions of justification entertained by those who in the present age have been considered as the leaders† of the sect of Arminians. How far they are just, the reader must decide for himself; but under every view of this doctrine which we have taken, the Christian covenant appears much more gracious than

† Warburton and Law, &c.

214 The Christian covenant more gracious than the paradisiacal.

that into which Adam was admitted in paradise: since it affords room for repentance, even to that man, who may be so unhappy as to be drawn for a time into apostasy from the terms of the covenant. Whether the death of Christ therefore was a *direct* atonement for the actual sins of men, or only operated as such *indirectly* by procuring for them repeated opportunities of repentance, it is an undoubted truth, that "if through the offence of one many be dead, much more the grace of God, and the gift by grace, which is by one man, Jesus Christ, hath abounded unto many. And not as it was by one that sinned, so is the gift: for the judgment was of one offence to *condemnation*, but the free gift is of many offences to *justification*‡."

‡ Rom. v. 16, 17.

Thus graciously has the divine goodness displayed itself in the restoration of our lost inheritance. But it stopt not here. The same bountiful Lord of life, for its further security, imparts to every true believer the strength and light of his holy spirit to support faith in working out our own salvation. Our blessed Saviour promised, before he left this world, to send to his followers the Holy Ghost or Comforter to abide with them for ever, to guide them into all truth, to bring all things to their remembrance whatsoever he had said unto them, and, as we learn from other passages of scripture, to "work in them both to will and to do of his good pleasure." How amply this promise was fulfilled to the apostles, we have already seen; but we are not to suppose that it was re-

215 Christians sanctified by the Holy Ghost, who

stricted to them. As man is designed for a supernatural state in heaven, he stands in need of supernatural direction to guide him to that state. "No man (says our Saviour) can come to me except the Father draw him; for as no man knoweth the things of a man save the spirit of a man which is in him, even so none knoweth the things of God but the Spirit of God." This omniscient Spirit indeed searcheth all things, yea even the deep things of God," and revealeth them to the sons of men, to enlighten their understandings and purify their hearts. The grace which he sheds abroad is either external and general, or internal and particular. The former has been extended to the whole church of God under the patriarchal, Mosaic, and Christian dispensations, in such a revelation of the divine will as was sufficient to instruct men unto eternal life, whether they had a clear view or not of that stupendous plan of redemption, by which the kingdom of heaven was opened to them after the forfeiture of the terrestrial paradise; for there have been "holy prophets ever since the world began;

Theology more peculiarly Christian.

began; and prophecy came not at any time by the will of man, but holy men of God spake as they were moved by the Holy Ghost *." Hence it is that all scripture was given by inspiration of God to teach us every thing which it is necessary for us to know and believe; and the scripture is that work of the Spirit which is extended to the universal church.

* Luke i. 70. and 2 Peter i. 21.

But the same spirit which thus generally reveals the object of faith to the church, does likewise particularly illuminate the minds of individual believers, working in them an assent to that which is taught them from the written word. It was thus that "the Lord opened the heart of Lydia †; that she attended to the things which were spoken by Paul;" it is thus that "the word preached doth not profit if it be not mixed with faith in them who hear it ‡;" and it is thus that "God deals to every man the measure of faith §;" for "by grace are we saved through faith, which is not of ourselves; it is the gift of God ||." This illumination of the Spirit was conveyed to the apostles "in a sound from heaven as of a rushing mighty wind," because it was meant to testify to the world that they were chosen ministers of the gospel; but the ordinary Christian receives it "in the still small voice," because it is conveyed to him only to "open his understanding that he may understand the scriptures."

† Acts xvi. 14.

‡ Heb. iv. 2.

§ Rom. xii. 3.

|| Eph. ii. 8.

216 Regenerates them,

Another operation of the Spirit on the minds of believers is that which in scripture is called REGENERATION; for "according to his mercy God saveth us by the washing of regeneration and renewing of the Holy Ghost *, which he sheds on us abundantly through Jesus Christ our Lord." To those who believe that we derive from Adam a corrupted nature, this particular grace must appear so absolutely necessary, that without it we could have no relish for heaven or heavenly things." "The natural man (we are told) receiveth not the things of the spirit of God; for they are foolishness to him; neither can he know them, because they are spiritually discerned." Indeed whatever be the powers of our moral faculties, when compared with those of our first father, it is so long before they be completely developed, that we should infallibly be lost, if we were not blessed by a supernatural guide, when reason is incapable of directing our conduct. Our passions and appetites are in their full strength before experience has furnished the mind with materials, by means of which motives may be weighed; and therefore it would be impossible, during the giddy period of youth, to keep them in due subjection, or to prevent vicious habits from being formed, were we not influenced by divine grace. So true is it, that "except a man be born again of water and of the Holy Ghost, he cannot enter into the kingdom of God." This change in our dispositione, from an immoderate attachment to earth to a relish for the things of heaven, is in scripture called "a renewing of our minds, a new creation, a new man;" in opposition to our natural disposition, which is called "the old man, corrupted according to the deceitful lusts." The ancient fathers of the church, as well as some very eminent modern divines †, generally speak of baptism as the instrument in God's hand of man's regeneration; and for the truth of their opinion they appeal to John iii. 3, 5. Ephes. v. 25, 26. and 1 Cor. vi. 11. in which great stress is certainly laid on the washing of water, as well as on sanctification by the word.

* Titus i. 5, 6.

† *Clarke* and *Waterland*.

217 guides them through life,

A third office of the Holy Spirit is to lead, direct, and govern us through all the periods of our lives. Without such a leader and guide, the temptations with which we are surrounded would certainly overcome us, and we should faint long before we arrive at the end of our journey. By the very constitution of our nature we are subjected in some degree to the influence of sense, of which the objects are present, whilst the enjoyments of heaven are future, and seen, as at a distance, only by the eye of faith; but "the law of the Spirit of life, in Christ Jesus, hath made us free from the law of sin and death;" for God worketh in us both to will and to do of his good pleasure; and as many as are thus led by the spirit of God, they are the sons of God; and while they walk in the Spirit, they do not fulfil the lusts of the flesh." Without the aid of the same Spirit, we could not even make our prayers acceptable; for since "our confidence in God is, that he heareth us only when we ask any thing according to his will; and since we know not what we should pray for as we ought, the Spirit itself maketh intercession for us with groanings which cannot be uttered *.

* Rom. viii. 26.

218 unites them to Christ,

A fourth operation of the Holy Ghost, as he is the sanctifier of Christians, is to join them to Christ, and make them members of that one body of which he is the head. "For by one Spirit are we all baptized into one body †; and as the body is one and hath many members, and all the members of that one body being many are one body, so also is Christ." "Hereby we know that God abideth in us, by the Spirit which he hath given us;" and as, in the ordinary course of his dealings with Christians, this Spirit is first given in baptism, so is it continued to the faithful by the instrumentality of the Lord's supper. That ordinance we have elsewhere (see *SUPPER of the Lord*) proved to be a federal rite; and surely no time can be supposed so highly sanctified for the reception of the graces of the Holy Spirit, as that in which we renew our federal union with our Lord and Master in the communion of his body and blood.

† 1 Cor. xii. 12, 13.

It is likewise the office of the Holy Ghost to give us an earnest of our everlasting inheritance, to create in us a sense of the paternal love of God, and thereby to assure us of the adoption of sons. "As many as are led by the Spirit of God, they are the SONS of God; and because we are sons, God hath sent forth the spirit of his Son into our hearts. For we have not received the spirit of bondage again to fear; but we have received the Spirit of adoption, whereby we cry Abba Father; the Spirit itself bearing witness with our spirit, that we are the children of God ‡."

‡ Gal. iv. 6. Rom. viii. 15, 16.

219 and sanctifies the administrations of the ministers of the gospel.

As the gifts of grace are generally annexed to means, to the proper use of the word and sacraments, it is a sixth office of the same Spirit to sanctify such persons as are regularly set apart for the work of the ministry, and ordained to offer up the public prayers of the people; to bless them in the name of God; to teach the doctrines of the gospel; to administer the sacraments instituted by Christ; and to perform all things necessary "for the perfecting of the saints, for the work of the ministry, for the edifying of the body of Christ §." The same Spirit which illuminated the apostles, and endowed them with power from above to perform personally their apostolic functions, fitted them also for sending others, as they were sent by their Divine Masters; and for establishing

§ Eph. iv. 12.

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blishing such a constitution of the church as was best adapted for preserving Christians in the unity of the Spirit and bond of peace. They committed a standing power to a successive ministry to be conveyed down to the end of the world; and those who are vested with that power are obliged to "take heed unto themselves, and to all the flock over which the HOLY GHOST hath made them overseers, to feed the church of God, and to contend earnestly for the faith which was once delivered unto the saints *." See EPISCOPACY, INDEPENDENTS, PRESBYTERIANS, POPE, and QUAKERS.

* Acts xx. 18. and Jude ver. 3.

By these, and the like means, doth the Spirit of God sanctify the sons of men; and in consequence of this santification proceeding immediately from his office, he is called the HOLY Spirit and the COMFORTER. This is such a provision "for renewing us in the spirit of our minds, and enabling us to put on the new man, which, after God, is created in righteousness and true holiness," as, when made known by revelation, appears to have been expedient, may be conceived to have been even necessary, and though reason could hardly have hoped for it, is contradicted by none of our natural notions either of God or of man. Many, however, are the controversies to which it has given rise in the church of God; some contending that it is given only unto the elect, upon whom it operates with resistless efficacy; others affirming that it is offered to all, but in such a manner as that, by the abuse of their free will, it may be "resisted, grieved, and quenched;" and some few, still intoxicated with the pride of PELAGIUS, think it is not necessary, and of course is not bestowed.

220 Controversies occasioned by this doctrine.

The questions concerning *election*, the *efficacy of grace*, and the final *perseverance of the saints*, we have stated elsewhere, and given a summary view of the arguments by which the contending parties maintain their respective opinions (see PREDESTINATION); and the texts of Scripture which we have just quoted, under the different heads of sanctification, show sufficiently that the opinion of Pelagius is directly contrary to the doctrine of the apostles. It may not be improper to enquire whether it be as agreeable to reason and experience as its patrons seem to imagine.

221 discussed elsewhere.

If it be unreasonable to expect any assistance from the Spirit of God in carrying on the work of our own salvation, how came so many of the wisest and best of men in all ages to believe, that he who sincerely endeavours to discharge his duty is supported in that endeavour by assistance from heaven? That such was the popular belief of the early Greeks, is evident from the poems of Homer; in which we everywhere find some god calming the passions of the heroes, altering their determinations when improper, and inspiring them with wisdom. Nor was this the sentiment of the poets only. Socrates, it is well known, professed to believe that his own conduct was under the direction of a superior spirit, which he called a *dæmon;* and Plutarch, as we find him quoted by Wollaston, speaks of the gods assisting men, by "exciting the powers or faculties of the soul; by suggesting secret principles, imaginations, or thoughts; or, on the contrary, by diverting or stopping them." Of the same opinion must Cicero have been, when he said, "stabit illud quidem, quod locum hunc continet, de quo agimus, esse Deos, et eorum providentia mundum administrari, eosdemque consulere rebus humanis, nec solum *universis*, verum etiam SINGULIS †;" for it is not conceivable that a particular providence can be administered without the influence of the Deity on the minds of men. That the poets and philosophers of the heathen world derived these notions from primeval tradition, cannot, we think, be questioned; but if they were absurd in themselves, or apparently contradictory to the laws of nature, they would not surely have been so universally embraced; for it will scarcely be denied, that Socrates and Cicero were men of as great natural sagacity as Pelagius or any of his followers. It is indeed so far from being incredible that the Father of spirits occasionally directs the thoughts and actions of men, that we believe there are very few who have made observations on themselves and their own affairs, who have not found, on reflection, many instances in which their usual judgment and sense of things were *overruled*, they know not *how*, or *why;* and that the actions which they performed in those circumstances have had consequences very remarkable in their general history. See PROVIDENCE, N° 18, 19.

222 Opinions of the heathens concerning it.

† *De Div.* lib. i. sect. 51.

This being the case, why should the pride of Christians make them hesitate to admit, on the authority of divine revelation, what Socrates, and Plutarch, and Cicero, and all the virtuous and wise men of antiquity, admitted in effect, on no better evidence than that of oral tradition, supported by their own meditations on their own thoughts, and the principles of their own conduct? Is it that they see not such beneficial effects of Christianity as to induce them to believe the professors of that religion to be indeed "chosen to salvation through the sanctification of the Spirit ‡?" Let them study the practical precepts of the gospel, consider the consequences which they have had on the peace and happiness of society, and compare the general conduct of Christians with that of the Jews, Pagans, and Mahometans (see RELIGION), and they will doubtless find reason to alter their opinion; and let those who embrace the truth remember, that as they are the temple of God, if the Spirit of God dwell in them, "it is their indispensable duty to cleanse themselves from all filthiness of the flesh and spirit; to follow peace with all men, and holiness, without which, no man shall see the Lord; and to work out their own salvation with fear and trembling, since it is God who worketh in them both to will and and to do of his good pleasure."

‡ Thess. ii. 3.

223 The gospel the last revelation.

From this short view of the several dispensations of revealed religion, it is evident that the gospel is not only the best but the last gift of the kind which man has to expect from his Maker; that the scheme of revelation is completed; and that the pretences of Mahomet and of more modern enthusiasts to divine inspiration are not only false, but fraught with contradictions. All these men admit the divine origin of the Mosaic and Christian religions; but it appears from the scriptures, in which those religions are taught, that the system of revealed truths which constitute the Patriarchal, Mosaic, and Christian revelations, commenced with the fall of man, and that it must therefore necessarily end with his restoration to life and immortality by the sacrifice of Christ upon the cross. A new revelation therefore like that of Mahomet cannot be admitted without rejecting the whole Bible, though the impostor himself everywhere acknowledges the inspiration of Abraham, of Moses, and of Christ. Nor is greater regard due to the claims of Christian enthusiasts. Such as pretend to have

have been in heaven *, and thence to have brought spiritual discoveries to the earth, have either forgotten or never understood, that in the scriptures of the Old and New Testaments the great scene of Providence appears to be closed in the full completion of its one regular, entire, and eternal purpose; that St Paul has pronounced † a curse on any man or angel from heaven who shall preach another gospel than what has been already preached by the apostles and evangelists; that in their writings we are taught every thing which it is our duty to believe or to practise in order to our own salvation; and that we have the promise of our blessed Lord himself, that the Spirit of truth shall remain with us to guide us into all necessary truth, till that great day when he shall come again to judge the world in righteousness, and render to every man according to his works.

* Bœhmen, Swedenbourg, and others.

† Gal. i. 8.

THE

THEOPHRASTA, a genus of plants belonging to the class of pentandria. See BOTANY *Index*.

THEOPHRASTUS, the philosopher, was born about 371 years before Christ, and was successively the disciple of Plato and of Aristotle. He succeeded Aristotle in the Peripatetic school, and conducted the charge with such high reputation that he had about 2000 scholars. He is highly celebrated for his industry, learning, and eloquence; and for his generosity and public spirit. He is said to have twice freed his country from the oppression of tyrants. He contributed liberally towards defraying the expence attending the public meetings of philosophers; which were held, not for the sake of show, but for learned and ingenious conversation. In the public schools he commonly appeared, as Aristotle had done, in an elegant dress, and was very attentive to the graces of elocution. He lived to the advanced age of 85: some say of 107. Towards the close of his life, he grew exceedingly infirm, and was carried to the school on a couch. He expressed great regret on account of the shortness of life; and complained that nature had given long life to stags and crows, to whom it is of so little value, and had denied it to man, who, in a longer duration, might have been able to attain the summit of science; but now, as soon as he arrives within sight of it, is taken away. His last advice to his disciples was, that, since it is the lot of man to die as soon as he begins to live, they would take more pains to enjoy life as it passes, than to acquire posthumous fame. His funeral was attended by a large body of Athenians. He wrote many valuable works, of which all that remain are, several treatises on the Natural History of Plants and Fossils; Of Winds, Of Fire, &c. a rhetorical work entitled "Characters," and a few Metaphysical Fragments.

Enfield's History of Philosophy.

To Theophrastus we are indebted for preserving the works of Aristotle. See ARISTOTLE.

THEOPOMPUS, a celebrated Greek orator and historian, was born in the island Chios, and flourished in the reign of Alexander the Great. He was one of the most famous of all the disciples of Isocrates, and won the prize from all the panegyrists whom Artemisia invited to praise Mausolus. He wrote several works, which are lost.

THEOREM, a proposition which terminates in theory, and which considers the properties of things already made or done; or it is a speculative proposition deduced from comparing together several definitions. A theorem is something to be proved, and a problem something to be done.

THE

THEORETIC, something relating to theory, or that terminates in speculation.

THEORY, in general, denotes any doctrine which terminates in speculation, without considering the practical uses or application thereof.

THEOSOPHISTS, a sect of men who pretend to derive all their knowledge from divine illumination. They boast that, by means of this celestial light, they are not only admitted to the intimate knowledge of God, and of all divine truth, but have access to the most sublime secrets of nature. They ascribe it to the singular manifestation of divine benevolence, that they are able to make such a use of the element of fire, in the chemical art, as enables them to discover the essential principles of bodies, and to disclose stupendous mysteries in the physical world. They even pretend to an acquaintance with those celestial beings which form the medium of intercourse between God and man, and to a power of obtaining from them, by the aid of magic, astrology, and other similar arts, various kinds of information and assistance.

Ibid.

To this class belonged Paracelsus, Robert Fludd, Jacob Bœhmen, Van Helmont, Peter Poiret, and the Rosicrucians. They are also called *FIRE-Philosophers*.

THERAPEUTÆ, a term applied to those that are wholly in the service of religion. This general term has been applied to particular sects of men, concerning whom there have been great disputes among the learned.

THERAPEUTICS, that part of medicine which acquaints us with the rules that are to be observed, and the medicines to be employed, in the cure of diseases.

THERMÆ, hot baths or bagnios. Luxury and extravagance were in nothing carried to such heights as in the thermæ of the Roman emperors. Ammian complains, that they were built to such an extent as to equal whole provinces; from which Valesius would abate, by reading *piscinæ* instead of *provinciæ*. And yet after all, the remains of some still standing are sufficient testimonies for Ammian's censure; and the accounts transmitted of their ornaments and furniture, such as being laid with precious stones (Seneca), set round with seats of solid silver (Pliny), with pipes and cisterns of the same metal (Statius), add to, rather than take from, the censure. The most remarkable bagnios were those of Dioclesian and Caracalla at Rome, great part of which remains at this day; the lofty arches, stately pillars, variety of foreign marble, curious vaulting of the roofs, great number of spacious apartments, all attract the curiosity of

Thermæ, Thermometer.

of the traveller. They had also their summer and winter baths.

THERMOMETER, an instrument for measuring the degree of heat or cold in any body.

1
Invention of the thermometer.
Martine's Essays.
* *Chem.* I. p. 152, 156.
† *Life of F. Paul*, p. 158.
‡ *Vit. Galil* p. 67.
|| *Corn. in Galen.* p. 756—842.
§ *De Mot. Animal.* II. prop. 175.
* *Opera Posth.* p. 30.

The thermometer was invented about the beginning of the 17th century; but, like many other useful inventions, it has been found impossible to ascertain to whom the honour of it belongs. Boerhaave * ascribes it to Cornelius Drebbel of Alcmar, his own countryman. Fulgenzio † attributes it to his master Paul Sarpi, the great oracle of the Venetian republic; and Viviani gives the honour of it to Galileo ‡. But all these are posthumous claims. Sanctorio || claims this honour to himself; and his assertion is corroborated by Borelli § and Malpighi * of the Florentine academy, whose partiality is not to be suspected in favour of a member of the Patavinian school.

Perhaps the best way to reconcile these different claims would be, to suppose that the thermometer was really invented by different persons about the same time. We know that there are certain periods in the progress of the arts when the stream of human genius runs in the same direction, and moves towards the same object. That part of the current which reaches the object first may possess the title; but the other parts follow so rapidly and arrive so soon after, that it is impossible for a spectator to decide which is first in point of time.

2
The air-thermometer described.

The first form of this instrument for measuring the degrees of heat and cold, was the air-thermometer. It is a well known fact that air expands with heat so as to occupy more space than it does when cold, and that it is condensed by cold so as to occupy less space than when warmed, and that this expansion and condensation is greater or less according to the degree of heat or cold applied. The principle then on which the air-thermometer was constructed is very simple. The air was confined in a tube by means of some coloured liquor; the liquor rose or fell according as the air became expanded or condensed. What the first form of the tube was, cannot now perhaps be well known; but the following description of the air-thermometer will fully explain its nature.

Plate DXXXIII. fig. 1.

The air-thermometer consists of a glass tube BE, fig. 1. connected at one end with a large glass ball A, and at the other end immersed in an open vessel, or terminating in a ball DE, with a narrow orifice at D; which vessel, or ball, contains any coloured liquor that will not easily freeze. Aquafortis tinged of a fine blue colour with a solution of vitriol or copper, or spirit of wine tinged with cochineal, will answer this purpose. But the ball A must be first moderately warmed so that a part of the air contained in it may be expelled through the orifice D; and then the liquor pressed by the weight of the atmosphere will enter the ball DE, and rise, for example, to the middle of the tube at C, at a mean temperature of the weather; and in this state the liquor by its weight, and the air included in the ball A, &c. by its elasticity, will counterbalance the weight of the atmosphere. As the surrounding air becomes warmer, the air in the ball and upper part of the tube, expanding by heat, will drive the liquor into the lower ball, and consequently its surface will descend; on the contrary, as the ambient air becomes colder, that in the ball is condensed, and the liquor pressed by the weight of the atmosphere will ascend; so that the liquor in the tube will ascend or descend more or less according to the state of the air contiguous to the instrument. To the tube is affixed a scale of the same length, divided upwards and downwards from the middle C into 100 equal parts, by means of which the ascent and descent of the liquor in the tube, and consequently the variations in the cold or heat of the atmosphere, may be observed.

3
Its defects.

This instrument was extremely defective; for the air in the tube was not only affected by the heat and cold of the atmosphere, but also by its weight.

4
The spirit of wine thermometer.

The air being found improper for measuring with accuracy the variations of heat and cold according to the form of the thermometer which was first adopted, another fluid was proposed about the middle of the 17th century by the Florentine academy. This fluid was spirit of wine, or alcohol, as it is now generally named. The alcohol being coloured, was inclosed in a very fine cylindrical glass tube previously exhausted of its air, having a hollow ball at one end A, fig. 2. and hermetically sealed at the other end D. The ball and tube are filled with rectified spirit of wine to a convenient height, as to C, when the weather is of a mean temperature, which may be done by inverting the tube into a vessel of stagnant coloured spirit, under a receiver of the air-pump, or in any other way. When the thermometer is properly filled, the end D is heated red hot by a lamp, and then hermetically sealed, leaving the included air of about one-third of its natural density, to prevent the air which is in the spirit from dividing it in its expansion. To the tube is applied a scale, divided from the middle, into 100 equal parts, upwards and downwards. Fig. 2.

As spirit of wine is capable of a very considerable degree of rarefaction and condensation by heat and cold, when the heat of the atmosphere increases the spirit dilates, and consequently rises in the tube; and when the heat decreases, the spirit descends, and the degree or quantity of the motion is shown by a scale.

5
Its defects.

The spirit of wine thermometer was not subject to some of the inconveniences which attended the air thermometer. In particular, it was not affected by variations in the weight of the atmosphere: accordingly it soon came into general use among philosophers. It was, at an early period, introduced into Britain by Mr Boyle. To this instrument, as then used, there are, however, many objections. The liquor was of different degrees of strength, and therefore different tubes filled with it, when exposed to the same degree of heat, would not correspond. There was also another defect: The scale which was adjusted to the thermometer did not commence at any fixed point. The highest term was adjusted to the great sunshine heats of Florence, which are too variable and undetermined; and frequently the workman formed the scale according to his own fancy. While the thermometer laboured under such disadvantages it could not be of general use. *Martine's Essays.*

6
Different fixed points proposed by philosophers.

To obtain some fixed unalterable point by which a determined scale might be discovered, to which all thermometers might be accurately adjusted, was the subject which next drew the attention of philosophers. Mr Boyle, who seems at an early period to have studied this subject with much anxiety, proposed the freezing of the essential oil of aniseeds as a convenient point for graduating thermometers; but this opinion he soon laid aside. Dr Halley next proposed that thermometers should

Thermometer.

should be graduated in a deep pit under ground, where the temperature both in winter and summer is pretty uniform; and that the point to which the spirit of wine should rise in such a subterraneous place should be the point from which the scale should commence. But this proposal was evidently attended with such inconveniences that it was soon abandoned. He made experiments on the boiling point of water, of mercury, and of spirit of wine; and he seems rather to give a preference to the spirit of wine *. He objected to the freezing of water as a fixed point, because he thought that it admitted considerable latitude.

* Phil. Trans. Abr. II. 34.

7 Sir Isaac Newton's oil thermometer.

It seems to have been reserved to the all-conquering genius of Sir Isaac Newton to determine this important point, on which the accuracy and value of the thermometer depends. He chose, as fixed, those points at which water freezes and boils; the very points which the experiments of succeeding philosophers have determined to be the most fixed and convenient. Sensible of the disadvantages of spirit of wine, he tried another liquor which was homogeneous enough, capable of a considerable rarefaction, about 15 times greater than spirit of wine. This was linseed oil. It has not been observed to freeze even in very great colds, and it bears a heat about four times that of water before it boils. With these advantages it was made use of by Sir Isaac Newton, who discovered by it the comparative degree of heat for boiling water, melting wax, boiling spirit of wine, and melting tin; beyond which it does not appear that this thermometer was applied. The method he used for adjusting the scale of this oil thermometer was as follows: Supposing the bulb, when immerged in thawing snow, to contain 10,000 parts, he found the oil expand by the heat of the human body so as to take up $\frac{1}{39}$th more space, or 10,256 such parts; and by the heat of water boiling strongly 10,725; and by the heat of melting tin 11,516. So that reckoning the freezing point as a common limit between heat and cold, he began his scale there, marking it 0, and the heat of the human body he made 12°; and consequently, the degrees of heat being proportional to the degrees of rarefaction, or 256 : 725 : : 12 : 34, this number 34 will express the heat of boiling water; and by the same rule, 72 that of melting tin †. This thermometer was constructed in 1701.

† Phil. Trans. N° 270. or Abr. vol. iv. part 2.

8 Its imperfections.

To the application of oil as a measure of heat and cold, there are insuperable objections. It is so viscid, that it adheres too strongly to the sides of the tube. On this account it ascends and descends too slowly in case of a sudden heat or cold. In a sudden cold, so great a portion remains adhering to the sides of the tube after the rest has subsided, that the surface appears lower than the corresponding temperature of the air requires. An oil thermometer is therefore not a proper measure of heat and cold.

9 Reaumur's spirit of wine thermometer.

All the thermometers hitherto proposed were liable to many inconveniences, and could not be considered as exact standards for pointing out the various degrees of temperature. This led Reaumur to attempt a new one, an account of which was published in the year 1730 in the Memoirs of the Academy of Sciences. This thermometer was made with spirit of wine. He took a large ball and tube, the dimensions and capacities of which were known; he then graduated the tube, so that the space from one division to another might contain 1000th part of the liquor; the liquor containing 1000 parts when it stood at the freezing point. He adjusted the thermometer to the freezing point by an artificial congelation of water: then putting the ball of his thermometer and part of the tube into boiling water, he observed whether it rose 80 divisions: if it exceeded these, he changed his liquor, and by adding water lowered it, till upon trial it should just rise 80 divisions; or if the liquor, being too low, fell short of 80 divisions, he raised it by adding rectified spirit to it. The liquor thus prepared suited his purpose, and served for making a thermometer of any size, whose scale would agree with his standard.

Martine's Essays on the Construction of Thermometers.

10 Its defects.

This thermometer was far from being perfect. As the bulbs were three or four inches in diameter, the surrounding ice would be melted before its temperature could be propagated to the whole spirits in the bulb, and consequently the freezing point would be marked higher than it should be. Dr Martine accordingly found, that instead of coinciding with the 32d degree of Fahrenheit, it corresponded with the 34th, or a point a little above it. Reaumur committed a mistake also respecting the boiling point; for he thought that the spirit of wine, whether weak or strong, when immerged in boiling water, received the same degree of heat with the boiling water. But it is well known that highly rectified spirit of wine cannot be heated much beyond the 175th degree of Fahrenheit, while boiling water raises the quicksilver 37 degrees higher. There is another thermometer that goes by the name of *Reaumur's*, which shall be afterwards described.

11 Mercurial thermometers.

At length a different fluid was proposed, by which thermometers could be made free from most of the defects hitherto mentioned. This fluid was mercury, and seems first to have occurred to Dr Halley in the last century; but it was not adopted by him on account of its having a smaller degree of expansibility than the other fluids used at that time *. Boerhaave says that the mercurial thermometer was first constructed by Olaus Roemer; but the honour of this invention is generally given to Fahrenheit of Amsterdam, who presented an account of it to the Royal Society of London in 1724.

* Phil. Trans. vol. xvii. or Abr. vol. ii.

That we may judge the more accurately of the propriety of employing mercury, we will compare its qualities with those of the fluids already mentioned, air, alcohol, and oil.

12 Properties of air, alcohol, and oil.

Air is the most expansible fluid, but it does not receive nor part with its heat so quickly as mercury. Alcohol does not expand much by heat. In its ordinary state it does not bear a much greater heat than 175 of Fahrenheit; but when highly rectified it can bear a greater degree of cold than any other liquor hitherto employed as a measure of temperature. At Hudson's Bay, Mr Macnab, by a mixture of vitriolic acid and snow, made it to descend to 69 below 0 of Fahrenheit. This is an inconvenience, however, attending the use of this liquor; it is not possible to get it always of the same degree of strength. As to oil, its expansion is about 15 times greater than that of alcohol; it sustains a heat of 600°, and its freezing point is so low that it has not been determined; but its viscosity renders it useless.

13 Thermometrical properties of mercury.

Mercury is superior to alcohol and oil, and is much more manageable than air. 1. As far as the experiments

Thermometer

Recherches sur les Mod. de l'Atmosphere.

ments already made can determine, it is of all the fluids hitherto employed in the construction of thermometers, that which measures most exactly equal differences of heat by equal differences of its bulk: its dilatations are in fact very nearly proportional to the augmentations of heat applied to it (A). 2. Of all liquids it is the most easily freed from air. 3. It is fitted to measure high degrees of heat and cold. It sustains a heat of 600° of Fahrenheit's scale, and does not congeal till it fall 39 or 40 degrees below 0. 4. It is the most sensible of any fluid to heat and cold, even air not excepted. Count Rumford found that mercury was heated from the freezing to the boiling point in 58 seconds, while water took two minutes 13 seconds, and common air 10 minutes and 17 seconds. 5. Mercury is a homogeneous fluid, and every portion of it is equally dilated or contracted by equal variations of heat. Any one thermometer made of pure mercury is, *cæteris paribus*, possessed of the same properties with every other thermometer made of pure mercury. Its power of expansion is indeed about six times less than that of spirit of wine, but it is great enough to answer most of the purposes for which a thermometer is wanted.

* *Phil. Trans.* for 1786.

14 Fixed points.

The fixed points which are now universally chosen for adjusting thermometers to a scale, and to one another, are the boiling and freezing points of water. The boiling water point, it is well known, is not an invariable point, but varies some degrees according to the weight and temperature of the atmosphere. In an exhausted receiver, water will boil with a heat of 98° or 100°; whereas in Papin's digester it will require a heat of 412. Hence it appears that water will boil at a lower point, according to its height in the atmosphere, or to the weight of the column of air which presses upon it. In order to ensure uniformity therefore in the construction of thermometers, it is now agreed that the bulb of the tube be plunged in the water when it boils violently, the barometer standing at 30 English inches (which is its mean height round London, and the temperature of the atmosphere 55°. A thermometer made in this way, with its boiling point at 212°, is called by Dr Horsley *Bird's Fahrenheit*, because Mr Bird was the first person who attended to the state of the barometer in constructing thermometers.

15 Rule for adjusting thermometers to these.

As artists may be often obliged to adjust thermometers under very different pressures of the atmosphere, philosophers have been at pains to discover a general rule which might be applied on all occasions. M. de Luc, in his *Recherches sur les Mod. de l'Atmosphere*, from a series of experiments, has given an equation for the allowance on account of this difference, in Paris measure, which has been verified by Sir George Shuckburgh*; also Dr Horsley, Dr Maskelyne, and Sir George Shuckburgh, have adapted the equation and rules to English measures, and have reduced the allowances into tables for the use of the artist. Dr Horsley's rule deduced from De Luc's, is this:

* *Phil. Trans.* for 1775 and 1778.

$$\frac{99}{8990000}\log. z - 92.804 = h,$$

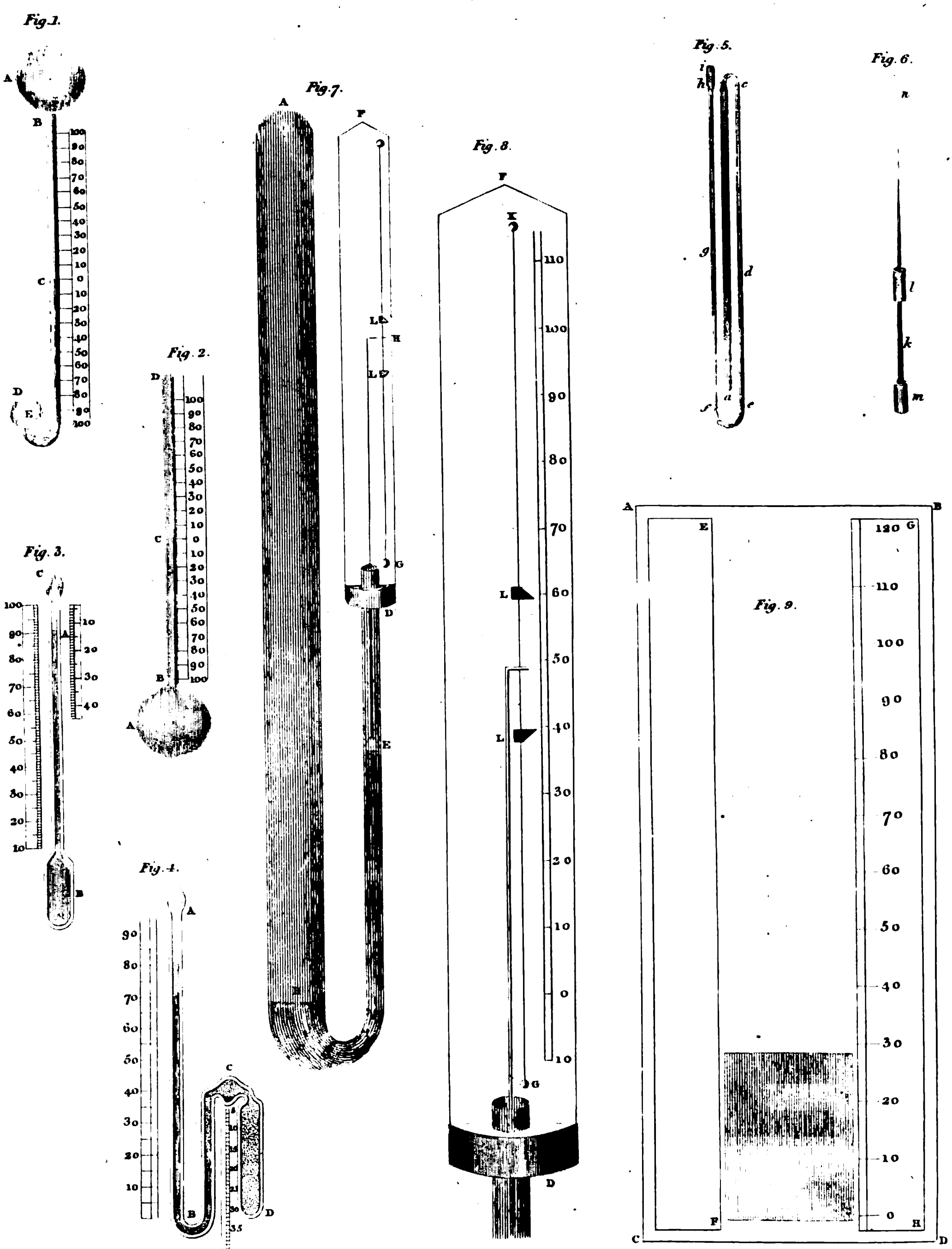
where h denotes the height of a thermometer plunged in boiling water, above the point of melting ice, in degrees of Bird's Fahrenheit, and z the height of the barometer in 10ths of an inch. From this rule he has computed the following table, for finding the heights, to which a good Bird's Fahrenheit will rise when plunged in boiling water, in all states of the barometer, from 27 to 31 English inches; which will serve, among other uses, to direct instrument-makers in making a true allowance for the effect of the variation of the barometer, if they should be obliged to finish a thermometer at a time when the barometer is above or below 30 inches; though it is best to fix the boiling point when the barometer is at that height.

Equation

(A) We have affirmed that the expansions of the bulk of quicksilver by heat are nearly (for they are not strictly so) in a regular arithmetical progression, according to the quantity of heat it is exposed to; and such seems to be the case according to the Table published by M. de Luc, at page 309 of his first volume on the Modifications of the Atmosphere. The following extract of this table shows these variations: and the first and second differences are added, in order to render these irregularities more sensible. They are such as can hardly be conceived from the nature of any substance, without the influence of extraneous and accidental causes, which may have escaped the attention of the observer; neither have they been found exactly true by Dr Crawford. M. de Luc supposes the whole heat from melting ice to that of boiling water to be divided into 80 parts; by the fractional subdivisions of which he expresses the absolute quantities of heat, answering to each 5 or 10 degrees of Reaumur's thermometer (=22,5 of Fahrenheit's scale); so that the whole sum of these fractions amounts exactly to the assumed number 80. They are as follow:

Cronstedt's Mineralogy, vol. ii.

	Reaumur's Thermometer.	*Fahrenheit's Thermometer.*	*Quantities of heat.*	*First differences.*	*Second differences.*
Degrees	80	212			
	70	189.5	9.44		
	60	167	9.60	.16	+ .06
	50	145.5	9.70	.10	— .06
	40	122	9.86	.16	— .06
	30	99.5	10.08	.22	+ .10
	20	77	10.20	.12	— .06
	10	54.5	10.38	.18	— .18
	0	32	10.74	.56	



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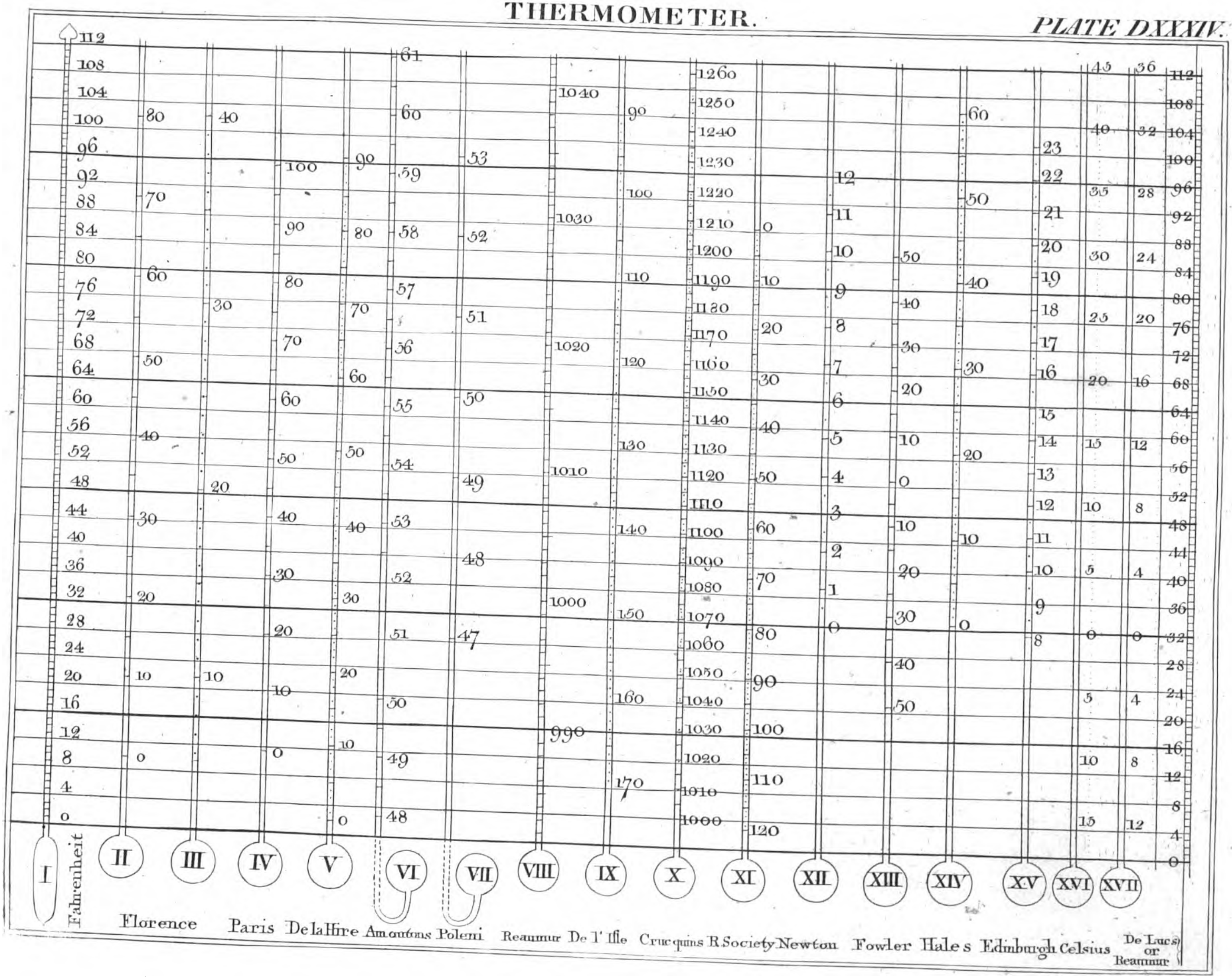


W. Train Sculpt.

Thermometer.

16
Table formed from the rule.

Equation of the Boiling Point.

Barometer.	*Equation.*	*Difference.*
31.0	+ 1.57	
30.5	+ 0.79	0.78
30.0	0.00	0.79
29.5	— 0.80	0.80
29.0	— 1.62	0.82
28.5	— 2.45	0.83
28.0	— 3.31	0.85
27.5	— 4.16	0.86
27.0	— 5.04	0.88

The numbers in the first column of this table express heights of the quicksilver in the barometer in English inches and decimal parts: the second column shows the equation to be applied, according to the sign prefixed, to 212° of Bird's Fahrenheit, to find the true boiling point for every such state of the barometer. The boiling point for all intermediate states of the barometer may be had with sufficient accuracy, by taking proportional parts, by means of the third column of differences of the equations. See Philosophical Transactions, vol. lxiv. art. 30.; also Dr Maskelyne's Paper, vol. lxiv. art. 20.

17
Sir George Shuckburgh's observations compared with De Luc's rules

In the following table we have the result of fifteen different observations made by Sir George Shuckburgh compared with the result of M. de Luc's rules.

Height of the Barometer reduced to the same temperature of 50°	Mean Boiling Point by observation.	Boiling Point by De Luc's Rules.	Height of Barometer.	Boiling Point by Observation.	Boiling Point by De Luc's Rules.
Inch.	°	°	Inch.	°	°
26.498	207.07	208.54	30.008	213.22	213.47
27.241	208.64	208.84	30.207	213.58	213.79
27.954	209.87	210.03	30.489	214.15	214.23
28.377	210.50	210.81	30.763	214.37	214.66
28.699	211.27	211.34	30.847	214.83	214.79
28.898	211.50	211.67	30.957	214.96	214.96
28.999	211.60	211.85			
29.447	212.55	212.74			
29.805	212.95	213.15			

Sir George Shuckburgh has also subjoined the following general table for the use of artists in constructing the thermometer, both according to his own observations and those of M. de Luc.

Height of the Barometer.	Correct. of the Boiling Point	Difference.	Correct. according to M. de Luc.	Difference.
	°		°	
26.0	— 7.09		— 6.83	
26.5	— 6.18	.91	— 5.93	.90
27.0	— 5.27	.91	— 5.04	.89
27.5	— 4.37	.90	— 4.16	.88
28.0	— 3.48	.89	— 3.31	.87
28.5	— 2.59	.89	— 2.45	.86
29.0	— 1.72	.87	— 1.62	.83
29.5	— 0.85	.87	— 0.80	.82
30.0	0.00	.85	0.00	.80
30.5	+ 0.85	.85	+ 0.79	.79
31.0	+ 1.69	.84	+ 1.57	.78

18
Observations made by a committee of the Royal Society for adjusting the fixed points.

The Royal Society, fully apprised of the importance of adjusting the fixed points of thermometers, appointed a committee of seven gentlemen to consider of the best method for this purpose; and their report is published in the Phil. Trans. vol. lxvii. part ii. art. 37.

They observed, that though the boiling point be placed so much higher on some of the thermometers now made than on others, yet this does not produce any considerable error in the observations of the weather, at least in this climate; for an error of $1\frac{1}{2}$° in the position of the boiling point, will make an error only of half a degree in the position of 92°, and of not more than a quarter of a degree in the point of 62°. It is only in nice experiments, or in trying the heat of hot liquors, that this error in the boiling point can be of much importance.

In adjusting the freezing as well as the boiling point, the quicksilver in the tube ought to be kept of the same heat as that in the ball. When the freezing point is placed at a considerable distance from the ball, the pounded ice should be piled to such a height above the ball, that the error which can arise from the quicksilver in the remaining part of the tube not being heated equally with that in the ball, shall be very small, or the observed point must be corrected on that account according to the following table:

19
Table for correcting the freezing point.

Heat of the Air.	Correction.
42°	.00087
52	.00174
62	.00261
72	.00384
82	.00435

The correction in this table is expressed in 1000th parts of the distance between the freezing point and the surface of the ice: e. gr. if the freezing point stands seven inches above the surface of the ice, and the heat of the room is 62, the point of 32° should be placed 7×00261, or .018 of an inch lower than the observed point. A diagonal scale will facilitate this correction.

Thermometer.

20 The quicksilver in the tube ought to be heated to the same degree as that in the ball.

The committee observe, that in trying the heat of liquors, care should be taken that the quicksilver in the tube of the thermometer be heated to the same degree as that in the ball; or if this cannot be done conveniently, the observed heat should be corrected on that account; for the manner of doing which, and a table calculated for this purpose, we must refer to their excellent report in the Phil. Trans. vol. lxvii. part ii. art. 37.

21 The tubes ought to be cylindrical and capillary.

With regard to the choice of tubes, they ought to be exactly cylindrical. But though the diameter should vary a little, it is easy to manage that matter in the manner proposed by the Abbé Nollet *, by making a small portion of the quicksilver, e. gr. as much as fills up an inch or half an inch, slide backward and forward in the tube; and thus to find the proportions of all its inequalities, and from thence to adjust the divisions to a scale of the most perfect equality. The capillary tubes are preferable to others, because they require smaller bulbs, and they are also more sensible, and less brittle. The most convenient size for common experiments has the internal diameter about the 40th or 50th of an inch, about nine inches long, and made of thin glass, that the rise and fall of the mercury may be better seen.

* *Leçons de Phys. Exp.* tom. iv. p. 376.

22 The number of degrees into which the scale ought to be divided.

The next thing to be considered, is of what number of degrees or divisions the scale ought to consist, and from what point it ought to commence. As the number of the divisions of the scale is an arbitrary matter, the scales which have been employed differ much from one another in this circumstance. Fahrenheit has made 180 degrees between the freezing and boiling water point. Amontons made 73, and Sir Isaac Newton only 34. There is, however, one general maxim, which ought to be observed: *That such an arithmetical number should be chosen as can easily be divided and subdivided, and that the number of divisions should be so great that there shall seldom be occasion for fractions.* The number 80 chosen by Reaumur answers extremely well in this respect, because it can be divided by several figures without leaving a remainder; but it is too small a number: the consequence of which is, that the degrees are placed at too great a distance from one another, and fractions must therefore be often employed. We think, therefore, that 160 would have been a more convenient number. Fahrenheit's number 180 is large enough, but when divided its quotient soon becomes an odd number.

23 At what point the scale ought to commence.

As to the point at which the scale ought to commence, various opinions have been entertained. If we knew the beginning or lowest degree of heat, all philosophers would agree, that the lowest point of the thermometer ought to be fixed there; but we know neither the lowest nor the highest degrees of heat; we observe only the intermediate parts. All that we can do, then, is to begin it at some invariable point, to which thermometers made in different places may easily be adjusted. If possible too, it ought to be a point at which a natural well-known body receives some remarkable change from the effects of heat or cold. Fahrenheit began his scale at the point at which snow and salt congeal. Kirwan proposes the freezing point of mercury. Sir Isaac Newton, Hales, and Reaumur adopted the freezing point of water. The objection to Fahrenheit's lowest point is, that it commences at an artificial cold never known in nature, and to which we cannot refer our feelings, for it is what few can ever experience. There would be several great advantages gained, we allow, by adopting the freezing point of mercury. It is the lowest degree of cold to which mercury can be applied as a measure; and it would render unnecessary the use of the signs plus and minus, and the extension of the scale below 0. But we object to it, that it is not a point well known; for few, comparatively speaking, who use thermometers, can have an opportunity of seeing mercury congealed. As to the other advantage to be gained by adopting the freezing point of mercury, namely, the abolition of negative numbers, we do not think it would counterbalance the advantage, to be enjoyed by using a well-known point. Besides, it may be asked, Is there not a propriety in using negative numbers to express the degree of cold, which is a negative thing? Heat and cold we can only judge of by our feelings: the point then at which the scale should commence, ought to be a point which can form to us a standard of heat and cold; a point familiar to us from being one of the most remarkable that occurs in nature, and therefore a point to which we can with most clearness and precision refer to in our minds on all occasions. This is the freezing point of water chosen by Sir Isaac Newton, which of all the general changes produced in nature by cold is the most remarkable. It is, therefore, the most convenient point, for the thermometers to be used in the temperate and frigid zones; we may say over the globe, for even in the hottest countries of the torrid zone many of the mountains are perpetually covered with snow.

24 Thermometers generally used.

The thermometers which are at present in most general use, are Fahrenheit's, De l'Isle's, Reaumur's, and Celsius's. Fahrenheit's is used in Britain, De l'Isle's in Russia, Reaumur's and the thermometre centigrade in France, and Celsius's, the same as the last named, in Sweden. They are all mercurial thermometers. For their description and the method of comparing them together, see CHEMISTRY, N° 198—201. See also Plate DXXXIV.

25 Account of self-registering thermometers.

As in meteorological observations it is necessary to attend to the greatest rise and fall of the thermometer, attempts have been made to construct a thermometer which might register the greatest degree of heat, or greatest degree of cold, which took place during the absence of the observer. In 1757 Lord Charles Cavendish presented to the Royal Society of London a thermometer in two different forms; the one contrived to mark the greatest degree of heat, and the other the greatest degree of cold.

26 Lord Charles Cavendish's thermometer.

Plate DXXXIII. fig. 3.

The first consists of a glass tube AB, fig. 3. with a cylindrical bulb B at the lower end, and capillary at the top, over which there is fixed a glass ball C. The bulb and part of the tube are filled with mercury, the top of which shows the degrees of heat as usual. The upper part of the tube above the mercury is filled with spirit of wine; the ball C is also filled with the same liquor almost to the top of the capillary tube. When the mercury rises the spirit of wine is also raised, and falls into the ball C, which is so made that the liquor cannot return into the tube when the mercury sinks; consequently the height of the spirit of wine in the ball, added to that in the tube, will give the greatest degree of heat to which the thermometer has pointed since last observation. When a new observation is to be made, the instrument must be inclined

Thermometer.

inclined till the liquor in the ball cover the end of the capillary tube.

In this thermometer it is evident that the mercury must be affected by the weight and elasticity of the spirit of wine, and therefore it will not correspond to any of the common mercurial thermometers.

Fig. 4.

The thermometer for showing the greatest degree of cold is represented in fig. 4. by the crooked tube ABCD. This instrument is filled with spirit of wine, with the addition of as much mercury as is sufficient to fill both legs of the syphon, and about a fourth or fifth part of the hollow ball C. We are not told what the proportion of mercury was to that of spirit of wine. The degrees of heat are shown by the rise or fall of the mercury in the leg AB. The thermometer marks the greatest fall by means of the hollow ball C. When the mercury in the longer leg sinks by cold, that in the shorter will rise and run over into the ball C, from which it cannot return when the mercury subsides in the shorter and rises in the longer leg. The upper part of the shorter leg will therefore be filled with a column of spirits of a length proportional to the increase of heat; the bottom or lower surface of which, by means of a proper scale, will show how much the mercury has been lower than it is; which being subtracted from the present height will give the lowest point to which the mercury has fallen. That the thermometer may be fitted for a new observation, the mercury must be made to run back from the ball into the shorter leg, by inclining the tube and heating the ball.

27
Mr Six's thermometer.
Fig. 5.

In 1782 Mr Six proposed another self-registering thermometer. It is properly a spirit of wine thermometer, though mercury is also employed for supporting an index. *a b*, fig. 5. is a thin tube of glass 16 inches long, and $\frac{5}{10}$ths of an inch caliber: *c d e* and *f g h* are smaller tubes about $\frac{1}{10}$th of an inch caliber. These three tubes are filled with highly rectified spirit of wine, except the space between *d* and *g*, which is filled with mercury. As the spirit of wine contracts or expands in the middle tube, the mercury falls or rises in the outside tubes.

Fig. 6.

An index, such as that represented in fig. 6. is placed on the surface, within each of these tubes, so light as to float upon it. *k* is a small glass tube $\frac{3}{4}$ths of an inch long, hermetically sealed at each end, and inclosing a piece of steel wire nearly of its own length. At each end *l*, *m*, of this small tube, a short tube of black glass is fixed, of such a diameter as to pass freely up and down within either of the outside tubes of the thermometer *e c* or *f h*. From the upper end of the index is drawn a spring of glass to the fineness of a hair, and about $\frac{4}{7}$ths of an inch long; which being placed a little oblique, presses lightly against the inner surface of the tube, and prevents the index from descending when the mercury descends. These indexes being inserted one into each of the outside tubes, it is easy to understand how they point out the greatest heat or cold that has happened in the observer's absence. When the spirit of wine in the middle tube expands, it presses down the mercury in the tube *h f*, and consequently raises it in the tube *e c*; consequently the index on the left hand tube is left behind and marks the greatest cold, and the index in the right hand tube rises and marks the greatest heat.

28
Rutherford's thermometer.

In 1790 a paper was given in to the Royal Society of Edinburgh, describing two thermometers, newly invented, by Dr John Rutherford of Middle Bailish; the one for registering the highest and the other for registering the lowest degree of heat to which the thermometer has risen or fallen during the absence of the observer. An account of them may be found in the third volume of the Transactions of the Society.

29
Mr Keith's thermometer.

A new self-registering thermometer has been invented by Mr Keith of Ravelstone, which we consider as the most ingenious, simple, and perfect, of any which has hitherto appeared. Its simplicity is so great, that it requires only a very short description to make it intelligible.

Fig 7.

AB, fig. 7. is a thin glass tube about 14 inches long and $\frac{3}{4}$ths of an inch caliber, close or hermetically sealed at top. To the lower end, which is open, there is joined the crooked glass tube BE, seven inches long, and $\frac{4}{10}$ths of an inch caliber, and open at top. The tube AB is filled with the strongest spirit of wine, and the tube BE with mercury. This is properly a spirit of wine thermometer, and the mercury is used merely to support a piece of ivory or glass, to which is affixed a wire for raising one index or depressing another, according as the mercury rises or falls. E is a small conical piece of ivory or glass, of such a weight as to float on the surface of the mercury. To the float is joined a wire called the *float-wire*, which reaches upwards to H, where it terminates in a knee bent at right angles. The float-wire, by means of an eye at *a*, moves easily along the small harpsichord wire GK. LL are two indexes made of thin black oiled silk, which slide upwards or downwards with a force not more than two grains. The one placed above the knee points out the greatest rise, and the one placed below it points out the greatest fall, of the thermometer.

When the instrument is to be prepared for an observation, both indexes are to be brought close to the knee H. It is evident, that when the mercury rises, the float and float-wire, which can be moved with the smallest force, will be pushed upwards till the mercury become stationary. As the knee of the float-wire moves upwards, it will carry along with it the upper index L. When the mercury again subsides, it leaves the index at the highest point at which it was raised, for it will not descend by its own weight: As the mercury falls the float-wire does the same; it therefore brings along with it the lower index L, and continues to depress it till it again becomes stationary or ascend in the tube; in which case it leaves the lower index behind it as it had formerly left the upper. The scale to which the indexes point is placed parallel to the slender harpsichord wire. It may be seen more distinctly in fig. 8. Fig. 8.
That the scale and indexes may not be injured by the wind and rain, a cylindrical glass cover, close at top, and made so as exactly to fit the part G F, is placed over it.

The ingenious inventor has another improvement in contemplation, which, if upon trial it be found to answer, will make this thermometer as perfect as can be desired, provided there do not arise some errors from the variable pressure of the atmosphere. He proposes to adapt clock-work to this thermometer, in such a way as to register with the utmost precision the degrees of heat and cold for every month, day, and minute in the year. The principles on which this clockwork is to be formed we shall forbear to describe, hoping that the author himself, after his experiment has met with the success which

which we ardently wish, will favour the world with his own account of it.

The same ingenious gentleman has invented a self-registering barometer, upon the same principles with the self registering thermometer. We have had the pleasure of seeing both; and are convinced that they will fully gratify the wishes of all who are engaged in meteorological studies. He is also in expectation of being soon able to produce an air-thermometer free from the defects of those which were formerly made, as he has found out a way of preventing it from being affected by the pressure of the atmosphere.

30 M. de Luc's supposed improvements.

M. de Luc has described the best method of constructing a thermometer, fit for determining the temperature of the air, in the mensuration of heights by the barometer. He has also shown how to divide the scale of a thermometer, so as to adapt it for astronomical purposes in the observation of refractions.

31 Mr Cavallo has proposed a thermometrical barometer.

Mr Cavallo, in 1781, proposed the construction of a thermometrical barometer, which, by means of boiling water, might indicate the various gravity of the atmosphere, or the height of the barometer. But as he does not say that the instrument has been tried with the desired success, we forbear to describe it. Those who wish to know his ideas respecting it may consult the Philosophical Transactions, vol. lxxi. p. 524.

32 The thermometers described above too limited.

The thermometers hitherto described are very limited in their extent; they indeed point out to us the lowest degrees of heat which are commonly observed even in cold climates, but they by no means reach to those degrees of heat which are very familiar to us. The mercurial thermometer extends no farther than to 600 of Fahrenheit's scale, the heat of boiling mercury; but we are sure that the heat of solid bodies, when heated to ignition, or till they emit light, far exceeds the heat of boiling mercury.

33 Sir Isaac Newton's method of extending the scale of the thermometer.

In order to remedy this defect, Sir Isaac Newton, whose genius overcame those obstacles which ordinary minds could not approach, attempted by an ingenious experiment to extend the scale to any degree required. Having heated a mass of iron red hot, and exposed it to the cold air, he observed the time which elapsed till it became cold, or of the same temperature with the air; and when the heat so far decreased that he could apply some known measure (as a thermometer) to it, he observed the degrees of heat lost in given times; and thence drew the general conclusion, that the quantities of heat lost in given small spaces are always proportional to the heat remaining in the body, reckoning the heat to be the excess by which it is warmer than the ambient air. So that taking the number of minutes which it took to cool after it came to a determined point in an arithmetical progression, the decrements of the heat of the iron would be continually proportional. Having by this proportion found out the decrements of heat in a given time after it came to a known point, it was easy, by carrying upwards the same proportion to the beginning of its cooling, to determine the greatest heat which the body had acquired. This proportion of Sir Isaac's was found by Dr Martine to be somewhat inaccurate. The heat of a cooling body does not decrease exactly in proportion to that which the body retains. As the result of many observations, he found that two kinds of proportion took place, an arithmetical as well as the geometrical proportion which Sir Isaac Newton had adopted; namely, that the decrements of heat were partly proportional to the times (that is, that quantities of heat are lost in equal times), as well as partly in proportion to the remaining heat; and that if these two are added together the rule will be sufficiently accurate. By the geometrical proportion which Sir Isaac Newton adopted he discovered the heat of metals red hot or in fusion.

Martine's Essays.

34 Mr Wedgwood's thermometer for measuring high degrees of heat

This method, so successfully pursued by Sir Isaac, was sufficient to form a scale of high degrees of heat, but was not convenient for practical purposes. Accordingly the late Mr Wedgwood invented a very simple thermometer which marks with much precision the different degrees of ignition, from a dull red heat visible in the dark to the heat of an air-furnace. It consists of two rulers fixed upon a smooth flat plate, a little farther asunder at the one end than at the other, leaving an open longitudinal space between them. Small pieces of alum and clay mixed together are made of such a size as just to enter at the wide end; and are heated along with the body whose heat we wish to determine. The earthy body contracts according to the degree of heat, so that when applied to the wide end of the gage, it will slide on towards the narrow end, less or more according to the degree of heat to which it has been exposed.

35 described. Fig. 9.

ABCD, fig. 9. is a smooth flat plate; and EF and GH two rulers or flat pieces, a quarter of an inch thick, fixed flat upon the plate, with the sides that are towards one another made perfectly true, a little farther asunder at one end EG than at the other end FH: thus they include between them a long converging canal, which is divided on one side into a number of small equal parts, and which may be considered as performing the offices both of the tube and scale of the common thermometer. It is obvious, that if a body, so adjusted as to fit exactly at the wider end of this canal, be afterwards diminished in its bulk by fire, as the thermometer pieces are, it will then pass further in the canal, and more and more so according as the diminution is greater; and conversely, that if a body, so adjusted as to pass on to the narrow end, be afterwards expanded by fire, as is the case with metals, and applied in that expanded state to the scale, it will not pass so far; and that the divisions on the side will be the measures of the expansions of the one, as of the contractions of the other, reckoning in both cases from that point to which the body was adjusted at first.

Philosophical Transactions, vol lxxiv.

I is the body whose alteration of bulk is thus to be measured. This is to be gently pushed or slid along towards the end FH, till it is stopped by the converging sides of the canal. See Chemistry, N° 1412.

A very ingenious application of Fahrenheit's thermometer has been made by Mrs Lovi, glass-blower in Edinburgh, for ascertaining the temperature of compost dunghills, for regulating the temperature of hot-beds, and observing the changes of temperature in corn and haystacks when they are put up damp. This may be called an agricultural thermometer, and has been found of great use for the above purposes.

THERMOPYLÆ, in *Ancient Geography*, a narrow pass or defile, between the Sinus Maliacus on the east, and a steep branch of Mount Oeta, covered with unpassable woods, on the west; leading from Thessaly to Locris and Bœotia. These mountains

tains divide Greece in the middle, in the same manner as the Apennine does Italy; forming one continued ridge from Leucate on the west to the sea on the east, with thickets and rocks interspersed. The valley is of small breadth, and completely occupied by a marsh, through which it is impossible for horse or foot to penetrate. Through the middle of this marsh a paved road was made by the Greeks, which still remains, and affords the only path to Greece from Thessaly. The Thermæ or hot springs, from which the place had its name, are near the narrowest part of the pass; and their temperature was found by Dr Clarke to be 111°. At the south entrance of the defile is a small eminence, on which Dr Clarke found a tumulus, with the remains of a massive pedestal of red breccia much time-worn, and evidently the tomb of the 300 Spartans, to whose immortal memories this monument was consecrated. The rising ground on which the monument stands is the spot where the Spartans fell. The remains of the wall which shut up the pass are also yet visible. For an account of the battle of Thermopylæ, see SPARTA.

THESEA, in antiquity, feasts celebrated by the Athenians in honour of Theseus, consisting of sports and games, with mirth and banquets. Such as were poor and unable to contribute to them were entertained at the public expence.

THESEUS, a famous hero of antiquity, ranked among the demigods, whose history is fabulous. He was the reputed son of Ægeus king of Athens. He threw Sciron, a cruel robber, down a precipice; fastened Procrustes tyrant of Attica to a bending pine, which being let loose tore him asunder; killed the Minotaur kept in the labyrinth by King Minos, in Crete; and by the assistance of that prince's daughter, Ariadne, who gave him a clue, escaped out of that labyrinth, and sailed with his deliverer to the isle of Naxos, where he had the ingratitude to leave her.

Theseus afterwards overcame the Centaurs, subdued the Thebans, and defeated the Amazons. He assisted his friend Pirithous in his expedition to the infernal regions to carry off Proserpine; but was imprisoned by Pluto, till he was released by Hercules. He is also said to have established the Isthmian games, in honour of Neptune; to have united the twelve cities of Attica; and to have founded a republic there, 1236 B.C. Some time after, taking a voyage into Epirus, he was seized by Aidonus king of the Molossians; meanwhile Menestheus rendered himself master of Athens. But at length Theseus being released from prison, retired to Scyros, where King Lycomedes caused him to be thrown from the top of a rock. Theseus had several wives; the first of whom was Helena the daughter of Tyndarus; the second, Hypolita queen of the Amazons; and the last, Phedra sister to Ariadne, who punished him for his infidelity to her sister, by her incestuous passion for his son Hippolitus.

THESIS, a general position which a person advances, and offers to maintain. In taking degrees in universities, the candidates are generally obliged to write a thesis, which they must afterwards defend.

THESIUM, BASE FLUELLIN; a genus of plants belonging to the class of pentandria, and order of monogynia. See BOTANY *Index*.

THESPIS, a famous Greek tragic poet, and the first representer of tragedy at Athens. He carried his troop from village to village in a waggon, from which they performed their pieces. Alcestis was the first tragedy they performed at Athens, 536 B. C. See THEATRE.

THESSALIAN CHAIR, so called from Thessaly, where chairs of this figure were most in use; it is recommended by Hippocrates* in place of a machine for reducing a recent luxation of the shoulder bone. The back of this chair is perpendicular to the seat, as Galen tells us; by which construction it is distinguished and accommodated to the operation.

* *Lib. de Art.*

THESSALY, a country of Greece, whose boundaries have been different at different periods. Properly speaking, Thessaly was bounded on the south by the southern parts of Greece, or Græcia Propria; east, by the Ægean; north, by Macedonia and Mygdonia; and west, by Illyricum and Epirus. It was generally divided into four separate provinces, Thessaliotis, Pelasgiotis, Istiæotis, and Phthiotis, to which some add Magnesia. It has been severally called *Æmonia*, *Pelasgicum*, *Argos*, *Hellas*, *Argeia*, *Dryopis*, *Pelasgia*, *Pyrrhæa*, &c. The name of Thessaly is derived from Thessalus, one of its monarchs. Thessaly is famous for a deluge which happened there in the age of Deucalion. Its mountains and cities are also celebrated, such as Olympus, Pelion, Ossa, Larissa, &c. The Argonauts were partly natives of Thessaly. The inhabitants of the country passed for a treacherous nation, so that false money was called *Thessalian coin*, and a perfidious action a *Thessalian deceit*. Thessaly was originally governed by kings, till it became subject to the Macedonian monarchs. The cavalry was universally esteemed, and the people were superstitious and addicted to the study of magic and incantations. See *Lucan*, lib. vi. ver. 438. &c.; *Dionys.* 219; *Curt.* lib. iii. cap. 2.; *Ælian*, *Var. Hist.* lib. iii. cap. 1.; *Paus.* lib. iv. cap. 36. lib. x. cap. 1.; *Mela*, lib. ii. cap. 3.; *Justin*, lib. vii. cap. 6.; *Diod.* iv. *Lempriere's Dictionary.*

Thessaly is now called *Janna*, a province of European Turkey, bounded by Macedonia on the north, by the Archipelago on the east, by Achaia or Livadia on the south, and by Epirus on the west.

THETIS, in Pagan mythology, the wife of Oceanus, and the mother of Nereus and Doris, who were married to each other; and from this marriage sprung the nymphs of the earth and sea. Among the sea nymphs there was one named *Thetis the Younger*, who excelled all the rest in beauty, and for whom Jupiter conceived such a passion, that he resolved to espouse her: but being informed by the Destinies that she would bring forth a son who would rise above his father, he married her to Peleus. To their nuptials all the gods and goddesses were invited except Discord, who, to be revenged for this contempt, threw a golden apple into the assembly, on which was engraven, *For the Fairest*. Juno, Pallas, and Venus, disputed for this apple; but Paris being chosen to decide the difference, adjudged it to Venus. From this marriage of Thetis and Peleus sprung Achilles.

THEURGY, θεουργια, a name which the ancients gave to that sacred part of magic which we sometimes call *white magic*, or the *white art*.

The word is formed from θεος, "God," and εργον, "work;" q. d. the art of doing divine things, or things which God alone can do: or the power of working extraordinary and supernatural things, by invoking the

names

names of God, saints, angels, &c. Accordingly, those who have written of magic in general, divide it into three parts: the first whereof is called *theurgy*, as operating by divine or celestial means; the second *natural magic*, performed by the powers of nature; and the third, comprehending *necromancy*, *sorcery*, and *witchcraft* or *magic*, performed by the assistance of demons or departed men. See MAGIC.

THIBET. See TIBET.

THIGH. See ANATOMY, N° 58.

THINKING, a general name for an act or operation of the mind. See METAPHYSICS.

THIRLAGE. See LAW, N° clxx. 12—18.

THIRST, an uneasy sensation arising from a deficiency of the saliva to moisten the inward parts of the mouth. Hence arises a strong desire for drink; and thirst is a symptom generally attending fevers of all kinds.—Thirst is best allayed by acids, water kept a while in the mouth, then spit out, and repeated as required; a pit of bread chewed with a little water, which latter may be gradually swallowed; if the person is very hot, brandy is the best for holding in the mouth, but should be spit out again: except in fevers, large draughts of cold water are hurtful.

Preservation against Hunger and THIRST. See HUNGER.

THISTLE, a name applied to different genera and species of plants belonging chiefly to the syngenesia class. See CARDUUS, ONOPORDUM, SERRATULA, SONCHUS, and also DIPSACUS, BOTANY *Index*.

Order of the THISTLE, or *of St Andrew*, a military order of knighthood in Scotland, the rise and institution of which is variously related by different authors. Lesley bishop of Ross reports, that the night before the battle between Athelstan king of Northumberland and Hungus king of the Picts, a bright cross, in form of that whereon St Andrew (the tutelar saint of Scotland) suffered martyrdom, appeared to Hungus; who having gained the victory, ever after bore the figure of that cross on his banners. Others assert, that Achaius king of Scotland first instituted this order, after having made the famous league offensive and defensive with Charlemagne king of France. But although the thistle had been acknowledged as the symbol of the kingdom of Scotland from the reign of Achaius, yet some refer the beginning of this order to Charles VII. of France. Others place the foundation of it as low as the year 1500.

The chief and principal ensign is a gold collar composed of thistles and sprigs of rue interlinked with amulets of gold, having pendent thereto the image of St Andrew with his cross, and the motto, NEMO ME IMPUNE LACESSET. "No body shall provoke me with impunity."

The ordinary or common ensign worn by the knights is a star of four silver points, and over them a green circle, bordered and lettered with gold, containing the said motto, and in the centre is a thistle; all which is embroidered on their left breast, and worn with the collar, with a green ribband over the left shoulder, and brought under the right arm; pendent thereto is the image of St Andrew, with his cross, in a purple robe, within an oval of gold enamelled vert, with the former motto; but sometimes they wear, encircled in the same manner, a thistle crowned.

About the time of the Reformation, this order was dropped, till James II. of Great Britain resumed it, by creating eight knights. The Revolution unsettled it again; and it lay neglected, till Queen Anne, in 1703, restored it to the primitive design, of twelve knights of St Andrew.

THLAPSI, BASTARD-CRESS, or *Mithridate-Mustard*; a genus of plants belonging to the class of tetradynamia. See BOTANY *Index*.

THOLOUSE. See TOULOUSE.

THOMÆANS, THOMISTS. See *CHRISTIANS of St Thomas*.

THOMAS AQUINAS. See AQUINAS.

St THOMAS's Day, a festival of the Christian church, observed on Dec. 21. in commemoration of St Thomas the apostle.

St THOMAS of Canterbury's Day, a festival of the Romish church, observed on Dec. 29. in memory of Thomas Becket archbishop of Canterbury, who was murdered, or as the Romanists say, martyred, in the reign of King Henry II.

THOMAS the Reymour, called also *Thomas Lermont* and *Thomas of Erceldon*, was born at Erceldon, or Earlston, a village near Melrose in Tweeddale, in what year is uncertain; but he was an old man when Edward I. was carrying on war in Scotland.

The character of Lermont as a prophet, and which was common to him with Linus, Orpheus, and other early poets in many countries, arose, if we may believe Mackenyie in his Lives of Scottish Writers, from his having conferences with Eliza, a nun and prophetess at Haddington. Lermont put her predictions into verse, and thus came in for his share of the prophetic spirit. None of these ancient prophecies now remain; but the following, which pretends to be one of them, is given from a manuscript of the time of Edward I. or II. The countess of Dunbar is the lady famous for the defence of her castle against the English. Her proper title was *Countess of March*; but it was common in these times to style a nobleman from his chief residence. Thus Gilbert Strongbow, earl of Pembroke, is called *Earl of Striguil*, from his residence at Striguil castle, near Chepstow, Monmouthshire, &c.

Pinkerton's Account of Scottish Poets.

La Countesse de Donbar demande a Thomas de Essedoune, quant la guere d'Escoce prendreit fyn. E yl la repoundy, et dyt—

When man as mad a kyng of a capped mon.
When mon is levere other mons thyng than is owen.
When londe thouys forest, and forest ys feide.
When hares kendles othe hersten.
When Wyt and Wille werres togedere.
When mon makes stables of kyrkes; and steles castles wyth styes.
When Rokesbourh nys no burgh; ant market is at Forwyleye.
When the alde is gan, and the newe is come that doue noht.
When Bambourne ys donged with dede men.
When men ledes men in ropes to buyen ant to sellen.
When a quarter of whaty whete is chaunged for a colt of ten markes.
When prude prikes, ant pees is leyd in priscun.
When a Scot ne may hym hude ase hare in forme, that the Englysh ne shall hym fynde.

When ryht ant wrong astente the togedere.
When laddes weddeth lovedies.
When Scottes flen so faste, that for faute of ship, hy
drouneth hemselve.
When shal this be ?
Nouther in thyne tyme, ne in myne.
Ah comen, ant gone,
Withinne twenty wynter ant'on.

In fact, the prophecies of Lermont appear to have been merely traditional; nay, it seems doubtful if he ever pretended to such folly, notwithstanding Mackenyie's story of Eliza. The reverence of the people for a learned and respectable character seems to have been the sole foundation of Thomas's claim to prophecy. But, in the 16th century, prophecies were made, and ascribed to him, as well as others given to Bede, Merlin, &c. (A). They were printed at Edinburgh, 1615; reprinted 1680, and 1742.

THOMISM. See Aquinas.

THOMSON, James, an excellent British poet, the son of a Scotch divine, was born in the shire of Roxburgh in 1700, and was educated in the university of Edinburgh with a view to the ministry. But his genius inclining him to the study of poetry, which he soon found would be incompatible with that of theology, or at least might prevent his being provided for in that way in his own country, he relinquished his views of engaging in the sacred function, and repaired to London in consequence of some encouragement which he had received from a lady of quality there, a friend of his mother.

The reception he met with wherever he was introduced, emboldened him to risk the publication of his excellent poem on Winter.—This piece was published in 1726; and from the universal applause it met with, Mr Thomson's acquaintance was courted by people of the first taste and fashion. But the chief advantage which it procured him was the acquaintance of Dr Rundle, afterward bishop of Derry, who introduced him to the late lord chancellor Talbot; and some years after, when the eldest son of that nobleman was to make his tour on the continent, Mr Thomson was chosen as a proper companion for him. The expectations which his Winter had raised, were fully satisfied by the successive publications of the other seasons; of Summer, in the year 1727; of Spring, in the following year; and of Autumn, in a quarto edition of his works, in 1730. Beside the Seasons, and his tragedy of Sophonisba, written and acted with applause in the year 1729, he had, in 1727, published his poem to the memory of Sir Isaac Newton, with an account of his chief discoveries; in which he was assisted by his friend Mr Gray, a gentleman well versed in the Newtonian philosophy. That same year the resentment of our merchants, for the interruption of their trade by the Spaniards in America, running very high, Mr Thomson zealously took part in it, and wrote his Britannia, to rouse the nation to revenge.

With the honourable Charles Talbot, our author visited most of the courts in Europe, and returned with his views greatly enlarged; not only of exterior nature and the works of art, but of human life and manners, and of the constitution and policy of the several states, their connections, and their religious institutions. How particular and judicious his observations were, we see in his poem of Liberty, begun soon after his return to England. We see at the same time to what a high pitch his care of his country was raised, by the comparisons he had all along been making of our happy government with those of other nations. To inspire his fellow-subjects with the like sentiments, and show them by what means the precious freedom we enjoy may be preserved, and how it may be abused or lost, he employed two years in composing that noble work, upon which he valued himself more than upon all his other writings. On his return to England with Mr Talbot (who soon after died), the chancellor made him his secretary of briefs; a place of little attendance, suiting his retired indolent way of life, and equal to all his wants. From this office he was removed, when death, not long after, deprived him of his noble patron. He then found himself reduced to a state of precarious dependence. In this situation, having created some few debts, and his creditors finding that he had no longer any certain support, became inexorable; and imagined by confinement to force that from his friends, which his modesty would not permit him to ask. One of these occasions furnished Quin, the celebrated actor, with an opportunity of displaying the natural goodness of his heart, and the disinterestedness of his friendship. Hearing that Thomson was confined in a spunging house for a debt of about 70l. he repaired to the place; and, having inquired for him, was introduced to the bard. Thomson was a good deal disconcerted at seeing Quin, as he had always taken pains to conceal his wants; and the more so, as Quin told him he was come to sup with him. His anxiety upon this head was however removed, upon Quin's informing him, that, as he supposed it would have been inconvenient to have had the supper dressed in the place they were in, he had ordered it from an adjacent tavern; and, as a prelude, half a dozen of claret was introduced. Supper being over, and the bottle circulating pretty briskly, Quin said, "It is time now we should balance accounts." This astonished Thomson, who imagined he had some demand upon him; but Quin perceiving it, continued, "Mr Thomson, the pleasure I have had in perusing your works I cannot estimate at less than a hundred pounds, and I insist upon now acquitting the debt." On saying this, he put down a note of that value, and took his leave, without waiting for a reply.

The profits arising from his works were not inconsiderable; his tragedy of Agamemnon, acted in 1738, yielded a good sum. But his chief dependence was upon the prince of Wales, who settled on him a handsome allowance, and honoured him with many marks of particular favour. Notwithstanding this, however, he was

(A) Sibilla and Banister Anglicus are mentioned in the time of Edward IV. (MSS. Cot. Dom. A. IX.). A long Latin prophecy of Bridlington is there given. Waldhave and Eltraine seem also English prophets. In the whole collection, therefore, Thomas is the only Scottish one.

Thomson. was refused a licence for his tragedy of Edward and Eleonora, which he had prepared for the stage in the year 1736, for some political reasons. Mr Thomson's next performance was the Masque of Alfred, written in the year 1740 jointly with Mr Mallet, by the command of the prince of Wales, for the entertainment of his royal highness's court at Clifden, his summer residence.

Mr Thomson's poem, entitled the Castle of Indolence, was his last work published by himself; his tragedy of Coriolanus being only prepared for the theatre, when a fatal accident robbed the world of one of the best of men and best of poets. He would commonly walk the distance between London and Richmond (where he lived) with any acquaintance that offered, with whom he might chat and rest himself, or perhaps dine by the way. One summer evening being alone in his walk from town to Hammersmith, he had over-heated himself, and in that condition imprudently took a boat to carry him to Kew; apprehending no bad consequence from the chill air on the river, which his walk to his house, towards the upper end of Kew-lane, had always hitherto prevented. But now the cold had so seized him, that the next day he was in a high fever. This, however, by the use of proper medicines, was removed, so that he was thought out of danger; till the fine weather having tempted him to expose himself once more to the evening dews, his fever returned with violence, and with such symptoms as left no hopes of a cure. His death happened on the 27th of August 1748.

Mr Thomson had improved his taste upon the finest originals, ancient and modern. The autumn was his favourite season for poetical composition, and the deep silence of the night he commonly chose for his studies. The amusement of his leisure hours were civil and natural history, voyages, and the best relations of travellers. Though he performed on no instrument, he was passionately fond of music, and would sometimes listen a full hour at his window to the nightingales in Richmond gardens; nor was his taste less exquisite in the arts of painting, sculpture, and architecture. As for the more distinguishing qualities of his mind and heart, they best appear in his writings. There his devotion to the Supreme Being, his love of mankind, of his country, and friends, shine out in every page; his tenderness of heart was so unbounded, that it took in even the brute creation. It is not known, that through his whole life he ever gave any person a moment's pain, either by his writings or otherwise. He took no part in the political squabbles of his time, and was therefore respected and left undisturbed by both sides. These amiable virtues did not fail of their due reward; the applause of the public attended all his productions, and his friends loved him with an enthusiastic ardour.

Johnson's Lives of the Poets. "As a writer (says Dr Johnson), he is entitled to one praise of the highest kind; his mode of thinking, and of expressing his thoughts, is original. His blank verse is no more the blank verse of Milton, or of any other poet, than the rhymes of Prior are the rhymes of Cowley. His numbers, his pauses, his diction, are of his own growth, without transcription, without imitation. He thinks in a peculiar train, and thinks always as a man of genius; he looks round on Nature and on life with the eye which Nature bestows only on a poet; the eye that distinguishes, in every thing represented to its view, whatever there is on which imagination can delight to be detained, and with a mind that at once comprehends the vast, and attends to the minute. The reader of the Seasons wonders that he never saw before what Thomson shews him, and that he never yet has felt what Thomson impresses."

Thomson ‖ Thornhill.

His testamentary executors were the lord Lyttelton, whose care of our poet's fortune and fame ceased not with his life; and Mr Mitchell, a gentleman equally noted for the truth and constancy of his private friendship, and for his address and spirit as a public minister. By their united interests, the orphan play of Coriolanus was brought on the stage to the best advantage; from the profits of which, and the sale of manuscripts and other effects, a handsome sum was remitted to his sisters. His remains were deposited in the church of Richmond, under a plain stone, without any inscription. A handsome monument was erected to him in Westminster abbey in the year 1762, the charge of which was defrayed by the profits arising from a splendid edition of all his works in 4to; Mr Millar the bookseller, who had purchased all Mr Thomson's copies, giving up his property on this grateful occasion. A monument has also been erected to him at the place of his birth.

THOR, the eldest and bravest of the sons of Odin and Frea, was, after his parents, the greatest god of the Saxons and Danes while they continued heathens. They believed, that Thor reigned over all the aerial regions, which composed his immense palace, consisting of 540 halls; that he launched the thunder, pointed the lightning, and directed the meteors, winds, and storms. To him they addressed their prayers for favourable winds, refreshing rains, and fruitful seasons; and to him the fifth day of the week, which still bears his name, was consecrated. *Henry's History of Great Britain, vol. ii. part iv.*

THORAX. See ANATOMY.

WHITE or *HAW* THORN. See CRATÆGUS, BOTANY *Index*.

THORN, a town of Poland, in Regal Prussia, and in the palatinate of Culm. It was formerly a Hanseatic town, but is now subject to Prussia; it is large and well fortified. Copernicus, the celebrated discoverer of the true system of the universe, was born here in 1472. It is seated on the Vistula, and contains 10,000 inhabitants. E. Long. 18. 30. N. Lat. 52. 55.

THORNBACK. See RAIA, ICHTHYOLOGY *Index*.

THORNHILL, SIR JAMES, an eminent English painter, was born in Dorsetshire in 1676, of an ancient family; but was constrained to apply to some profession by the distresses of his father, who had been reduced to the necessity of selling his family estate. His inclination directed him to the art of painting; and on his arrival at London he applied to his uncle, the famous Dr Sydenham, who enabled him to proceed in the study of the art under the direction of a painter who was not very eminent. However, the genius of Thornhill made ample amends for the insufficiency of his instructer, and by a happy application of his talents he made so great a progress, that he gradually rose to the highest reputation. *Dictionary of Painters.*

His genius was well adapted to historical and allegorical compositions; he possessed a fertile and fine invention; and he sketched his thoughts with great ease, freedom, and spirit. He excelled also equally in portrait,

trait, perspective, and architecture; shewed an excellent taste for design, and had a free and firm pencil. Had he been so fortunate as to have studied at Rome and Venice, to acquire greater correctness at the one, and a more exact knowledge of the perfection of colouring at the other, no artist among the moderns might perhaps have been his superior. Nevertheless, he was so eminent in many parts of his profession, that he must for ever be ranked among the best painters of his time; and his performances in the dome of St Paul's church at London, in the hospital at Greenwich, and at Hampton-court, are such public proofs of his merit as will convey his name to posterity with great honour.

This painter lived in general esteem; he enriched himself by the excellence of his works; was appointed state-painter to Queen Anne, from whom he received the honour of knighthood; had the singular satisfaction to repurchase his family estate; and was so much distinguished as to be elected one of the members of parliament. He died in 1732.

THOROUGH-WAX, in *Botany*. See BUPLEURUM.

THOTH, or THEUT, (called by the Phœnicians *Taaut*, by the Greeks *Hermes*, and by the Romans *Mercury*), was a Phœnician of very superior talents, and one of the civilizers of mankind. He was prime minister to Osiris, whom, after his death, he deified; and he was himself deified by his countrymen the Egyptians, for the benefits that he had rendered to the human race. See MERCURY, MYTHOLOGY, N° 34. and POLYTHEISM, N° 18.

THOUGHT, a general name for all the ideas consequent on the operations of the mind, and even on the operations themselves. See METAPHYSICS.

THOUGHT, in composition. See ORATORY, Part I. and II.

THOUINIA, a genus of plants belonging to the class of diandria, and order of monogynia. See BOTANY *Index*.

THRACE, a country very frequently mentioned by the Greek and Latin writers, deriving its name, according to Josephus, from Tiras one of the sons of Japhet. It was bounded on the north by Mount Hæmus; on the south, by the Ægean sea; on the west, by Macedon and the river Strymon; and on the east, by the Euxine sea, the Hellespont, and the Propontis.—The Thracian Chersonesus is a peninsula inclosed on the south by the Ægean sea, on the west by the gulf of Melas, and on the east by the Hellespont; being joined on the north to the continent by a neck of land about 37 furlongs broad. The inland parts of Thrace are very cold and barren, the snow lying on the mountains the greatest part of the year; but the maritime provinces are productive of all sorts of grain and necessaries for life; and withal so pleasant, that Mela compares them to the most fruitful and agreeable countries of Asia.

The ancient Thracians were deemed a brave and warlike nation, but of a cruel and savage temper; being, according to the Greek writers, strangers to all humanity and good nature. It was to the Thracians, however, that the Greeks were chiefly indebted for the polite arts that flourished among them; for Orphæus, Linus, Musæus, Thamyris, and Eumolpus, all Thracians, were the first, as Eustathius informs us, who charmed the inhabitants of Greece with their eloquence and melody, and persuaded them to exchange their fierceness for a sociable life and peaceful manners; nay, great part of Greece was anciently peopled by Thracians. Tereus, a Thracian, governed at Daulis in Phocis, where the tragical story of Philomela and Progne was acted. From thence a body of Thracians passed over to Eubœa, and possessed themselves of that island. Of the same nation were the Aones, Tembices, and Hyanthians, who made themselves masters of Bœotia; and great part of Attica itself was inhabited by Thracians, under the command of the celebrated Eumolpus. It is not, therefore, without the utmost ingratitude and injustice that the Greeks style them *Barbarians*, since to them chiefly they were indebted both for the peopling and polishing of their country.

Thrace was anciently divided into a number of petty states, which were first subdued by Philip of Macedon. On the decline of the Macedonian empire, the country fell under the power of the Romans. It continued under subjection to them till the irruption of the Turks, in whose hands it still remains.

THRASHING, in *Agriculture*, the operation by which corn is separated from the straw. This operation is performed in a variety of ways, sometimes by the feet of animals, sometimes by a flail, and sometimes by a machine.

The most ancient method of separating the corn from the straw was by the hoofs of cattle or horses. This was practised by the Israelites, as we find from the books of Moses; it was also common among the Greeks and Romans*. Flails and thrashing machines were also not uncommon among these nations†. The flail which was used by the Romans, called *baculus*, *fustis*, or *pertica*, was probably nothing more than a cudgel or pole. The thrashing machine, which was called *tribula* or *tribulum*, and sometimes *traha*, was a kind of sledge made of boards joined together, and loaded with stone or iron. Horses were yoked to this machine, and a man was seated upon it to drive them over the sheaves of corn.

* *Pliny*, xviii. 30. *Virgil.* Georg. iii. 132. *Col.* ii. 21. *Tibull.* i. 5. 21.

† Isaiah xviii. 27. *Homer*, Il. xx. 495.

Different methods are employed in different countries for separating the corn from the stalk. In the greatest part of France the flail is used; but in the southern districts it is generally performed by the feet of animals. Animals are also used for the same purpose in Spain, in Italy, in the Morea, in the Canaries, in China, and in the vicinity of Canton, where the flail is also sometimes used. It appears that in hot climates the grains do not adhere so firmly to the stalk as in cold countries, and therefore may be more easily separated. This will explain the reason why animals are so frequently employed in hot countries for treading out the corn; whereas in cold climates we know they are seldom tried, and have no reason to suppose thst they would answer the purpose. In the Isle of France in Africa, rice and wheat are thrashed with poles, and maize with sticks; for it has not been possible to teach the negroes the use of the flail.

The animals used for treading out corn are, oxen, cows, horses, mules, and even asses when the quantity is not great. The operation is performed in this manner: The sheaves, after being opened, are spread in such a manner that the ears of the corn are laid as much uppermost as possible, and a man, standing in the centre, holds the halters of the cattle, which are made to trot round as in a manege; whilst other men with forks

forks shake the straw up from time to time, and the cattle are trotted over it again and again till they have beaten out all the grain. This method is expeditious enough; but besides bruising a considerable quantity of corn, it requires a great many cattle, and injures the legs of the horses and mules, which are preferred before cows and oxen for this work.

The flail is undoubtedly a much better instrument for thrashing corn than the feet of animals, for it separates the grain from the straw and husks both more effectually and more expeditiously; yet it is liable to many objections. It is a very laborious employment, too severe indeed even for a strong man; and as it is usually the interest of the thrasher rather to thrash much than to thrash clean, a good deal of corn will generally be left upon the straw. It is therefore an object of great importance in husbandry to procure a proper machine for separating the corn from the straw.

The first thrashing machine attempted in modern times, of which we have received any account, was invented in Edinburgh by Mr Michael Menzies about the year 1732. It consisted of a number of instruments like flails, fixed in a moveable beam, and inclined to it at an angle of ten degrees. On each side of the beam in which the flails were fixed, floors or benches were placed for spreading the sheaves on. The flails were moved backwards and forwards upon the benches by means of a crank fixed on the end of an axle, which made about 30 revolutions in a minute.

The second thrashing machine was invented by Mr Michael Stirling, a farmer in the parish of Dunblane, Perthshire. Of this discovery we have received a very accurate and authentic account from his son, the reverend Mr Robert Stirling minister of Crieff.

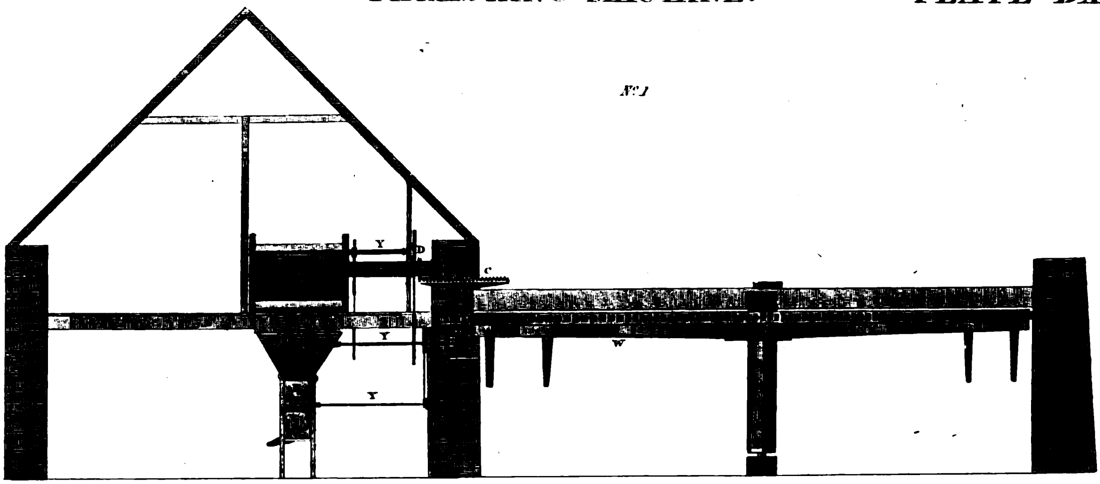
It is an old proverb, that necessity is the mother of invention. This was verified on the present occasion. Besides his ordinary domestic servants, Mr M. Stirling had occasion sometimes to hire an additional number to thrash out his grain, and frequently found it difficult to procure so many as he needed. This naturally led him to reflect whether the operation of thrashing could not easily be performed by machinery. Accordingly, so early as the year 1753, under the pretence of joining in the amusements of his children, he formed in miniature a water mill, in which two iron springs made to rise and fall alternately, represented the motion of two flails, by which a few stalks of corn put under them might be speedily thrashed. This plan he executed on a scale sufficiently large within two years after, making the springs about ten feet long, each of which had one end firmly screwed into a solid plank, and the other terminated in a round batoon of solid iron, two feet long and above an inch in diameter. Under these the sheaves were conveyed gradually forward in a narrow channel or trough, by passing between two indented horizontal cylinders, similar to those now used in the most of the thrashing mills in that part of the country, and called *feeders*. In this manner the thrashing was executed completely, and with considerable rapidity; but as the operation was performed on a low floor, and no method contrived for carrying off the straw, the accumulation of it produced such confusion, and the removal of it was attended with such danger that this scheme was very soon entirely abandoned. The mortification arising from disappointment, and especially the scoffs of his neighbours, for what was universally accounted an absurd and ridiculous attempt, served only to stimulate the exertions of the inventor to accomplish his designs on another plan.

Laying aside therefore the iron springs with the feeders, and all the apparatus adapted to them, he retained only an outer or water wheel, with an inner or cog-wheel moving on the same axle: to this inner wheel, which had 48 teeth or cogs, he applied a vertical trundle or pinion, with seven notches, the axle of which passed through a floor above the wheel, and having its upper pivot secured in a beam six feet above that floor. At the distance of three feet three inches above the floor two straight pieces of squared wood, each four feet long, passed through the axle of the trundle at right angles, forming four arms, to be moved round horizontally. To the extremities of these arms were fixed four iron plates, each 20 inches long, and eight broad at the end next the arms, but tapering towards a point at the other end. This large horizontal fly constituting four thrashers, was inclosed within a wooden cylindrical box three feet and a half high and eight in diameter. On the top of the box was an opening or port (two or three ports were made at first, but one was found sufficient) eight inches wide, and extending from the circumferece a foot and a half towards its centre, through which the corn sheaves descended, being first opened and laid one by one on a board with two ledges gently declining towards the port; on which board they were moderately pressed down with a boy's hand, to prevent them from being too hastily drawn in by the repeated strokes of the thrashers. Within the box was an inclined plane, along which the straw and grain fell down into a wide wire riddle two feet square, placed immediately under a hole of nearly the same size. The riddle received a jerk at every revolution of the spindle from a knob placed on the side of it, and was instantly thrust backward by a small spring pressing it in the opposite direction. The short straw, with the grain and chaff which passed through the wide riddle, fell immediately into an oblong straight riddle, which hung with one end raised and the other depressed, and was moved by a contrivance equally simple as the other; and having no ledge at the lower end, the long chaff which could not pass through the riddle dropped from thence to the ground; while the grain and most of the chaff falling through the riddle into a pair of common barn-fanners that stood under it on the ground floor, the strong grain, the weak, and the chaff, were all separated with great exactness. The fanners were moved by a rope or band running circuitously in a shallow niche cut on the circumference of the cog-wheel. The straw collected gradually in the bottom of the box over the wide riddle, and through an opening two and a half feet wide, and as much in height, left in that side of the box nearest the brink of the upper floor, was drawn down to the ground with a rake by the person or persons employed to form it into sheaves or rolls.

Such was the thrashing mill invented by Mr Michael Stirling, which, after various alterations and improvements he completed in the form now described, A. D. 1758. By experiment it was found that four bolls of oats, Linlithgow measure, could be thrashed by it in 25 minutes. From that period he never used a common flail in thrashing, except for humbling or bearding barley.

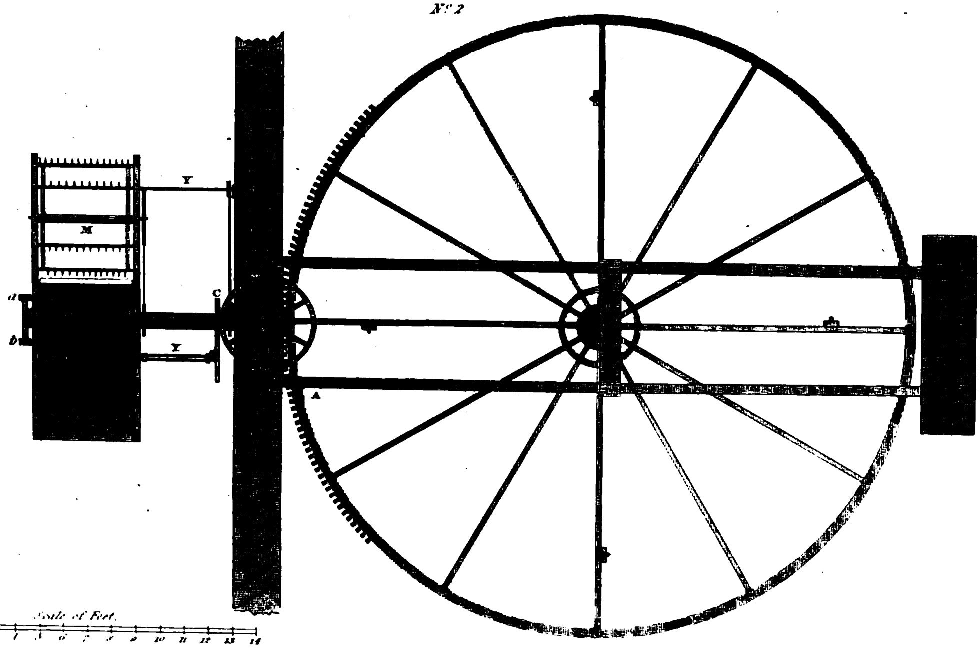
THRASHING MACHINE. PLATE DXXXV.

No. 1



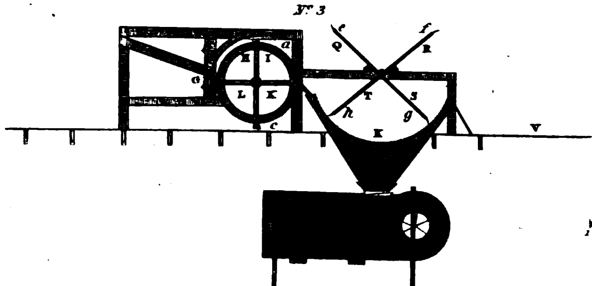
Scale of Feet.

No. 2



Scale of Feet.

No. 3



Scale of Feet.

Engraved by W. & D. Lizars Edinburgh

Thrashing. ley. In every other kind of grain he performed the whole operation of thrashing with the mill; and continued always to use it till 1772, when he retired from business, and his thrashing mill became the property of his second son, who continued to use it with equal advantage and satisfaction. Several machines were constructed on the same plan, particularly one near Stirling, under Mr Stirling's direction, for Mr Moir of Leckie, in 1765, which, we undertand, has been used ever since, and gives complete satisfaction to the proprietor. There was another erected in 1778 by Mr Thomas Keir (in the parish of Muthil and county of Perth), who has contrived a method of bearding barley with it: and by the addition of a small spindle with short arms contiguous to the front of the box, and moved by a band common to it and the great spindle to which it is parallel, the straw is shaken and whirled out of the box to the ground. That this machine did not come immediately into general use, was owing partly to the smallness of the farms in that part of the country, whose crops could easily be thrashed by the few hands necessarily retained on them for other purposes; and chiefly to an apprehension that the machine could only be moved by water; an apprehension which experience proves to be entirely groundless. The machine, however, was ingenious, and did great credit to the worthy inventor, and certainly deserved a better fate than it was destined to undergo.

A third thrashing mill was invented in 1772, by two persons nearly about the same time, and upon the same principles. The inventors were, Mr Alderton who lived near Alnwick, and Mr Smart at Wark in Northumberland. The operation was performed by rubbing. The sheaves were carried round between an indented drum of about six feet diameter, and a number of indented rollers arranged round the circumference of the drum, and attached to it by means of springs; so that while the drum revolved, the fluted rollers rubbed the corn off from the straw by rubbing against the flutings of the drum. But as a considerable quantity of the grain was bruised in passing between the rollers, the machine was soon laid aside.

In 1776 an attempt was made by Mr Andrew Meikle, an ingenious millwright in the parish of Tyninghame, East Lothian, to construct a new machine upon the principles which had been adopted by Mr Menzies already mentioned. This consisted in making joints in the flails, which Mr Menzies had formed without any. But this machine, after much labour and expence, was soon laid aside, on account of the difficulty of keeping it in repair, and the small quantity of work performed, which did not exceed one boll or six Winchester bushels of barley per hour.

Some time after this, Mr Francis Kinloch, then junior of Gilmerton, having visited the machine invented in Northumberland, attempted an improvement upon it. He inclosed the drum in a fluted cover; and instead of making the drum itself fluted, he fixed upon the outside of it four fluted pieces of wood, which by means of springs could be raised a little above the circumference of the drum, so as to press against the fluted covering, and thus rub off the ears of corn as the sheaves passed round between the drum and the fluted covering. But not finding this machine to answer his expectation (for it bruised the grain in the same manner as the Northumberland machine did), he sent it to Mr Meikle, that he might, if possible, rectify its errors. Thrashing.

Mr Meikle, who had long directed his thoughts to this subject, applied himself with much ardour and perseverance to the improvement and correction of this machine; and after spending a good deal of time upon it, found it was constructed upon principles so erroneous, that to improve it was impracticable.

At length, however, Mr Meikle's own genius invented a model, different in principle from the machines which had already been constructed. This model was made in the year 1785; and in the following year the first thrashing machine on the same principles was erected in the neighbourhood of Alloa, in the county of Stirling, by Mr George Meikle the son of the inventor. This machine answered completely the wishes of Mr Stein, the gentleman for whom it was erected, who gave the most ample testimony of his satisfaction both to the inventor and to the public. The fame of this discovery soon spread over the whole country, and a great many farmers immediately applied to Mr Meikle, desiring to have thrashing-mills erected on their farms. The discovery, it appeared, would be profitable, and it was reasonable that the inventor should enjoy the profits of his invention. He accordingly applied for a patent; which, after considerable expence, arising from the opposition of some persons, who claimed a share in the discovery, was granted.—These machines are now becoming very common in many parts of Scotland, and are increasing very considerably in number every year over all the united kingdom.

We will now endeavour to describe this machine in its most improved state; which is so simple, that with the assistance of a plate, exhibiting the plan of elevation, fig. 1. the ground plan, fig. 2. and the 3d showing its essential parts in a distinct manner, we hope it will be easily understood by all our readers who have not had an opportunity of seeing it. The power employed for turning that part of the machine which separates the corn from the straw is produced by four wheels (when moved by horses), the teeth of which move in one another and turn the drum, on which four scutchers are fixed. The sheaves are introduced between two fluted rollers, which hold them firm, and draw them in gradually, while the scutchers strike off the grain from the straw as it passes through. This will suffice for a general idea of this machine. We will now be more particular. Plate DXXXV.

The large spur-wheel A, fig. 1. and 2. which has 276 cogs, is horizontal, and moves the pinion D, which has 14 teeth. The pinion B moves the crown-wheel C, which has 84 teeth; the wheel C moves a second pinion D, which has 16 teeth; and the pinion D moves the drum HIKL. The drum is a hollow cylinder three feet and a half diameter, and placed horizontally; on the outside of which the scutchers are fixed by strong screw bolts. The scutchers consist of four pieces of wood, faced on one side with a thin plate of iron, placed at an equal distance from each other, and at right angles to the axis of the drum. Fig. 1. and 2.

The sheaves are spread on an inclined board F, fig. 3. from which they are introduced between two fluted rollers GG made of cast iron, about three inches and a half in diameter, and making about 35 revolutions in a minute. As these rollers are only about three quarters of Fig. 3.

Thrashing. of an inch distant from the scutchers or leaves of the drum HIKL, they serve to hold the sheaves fast, while the scutchers *a*, *b*, *c*, *d*, moving with prodigious velocity, separate the grain completely from the straw, and at the same time throw out both grain and straw upon the concave rack M, lying horizontally with slender parallel ribs, so that the corn passes through them into a hopper N placed below. From the hopper it passes through a harp or riddle O into a pair of fanners P, from which, in the most improved machines, it comes out clean and fit for the market. The straw, after being thrown by the scutchers *a*, *b*, *c*, *d*, into the rack, is removed from it by a rake QRST into a place contiguous V. The rake consists of four thin pieces of wood or leaves; on the end of each of these leaves is ranged a row of teeth *e*, *f*, *g*, *h*, five inches long. The rake moves in a circular manner in the convave rack, while the teeth catch hold of the straw, and throw it out of the rack. These are all the essential parts of the machine; the rest may be easily understood by the references to the plate. W is the horse-course, N° 1, which is 27 feet diameter. X is the pillar for supporting the beams on which the axle of the spur-wheel is fixed. YYY are three spindles for moving the two fluted rollers, the rake, and fanners. To the description now given we have only to add, that the drum has a covering of wood Z at a small distace above it, for the purpose of keeping the sheaves close to the scutchers.

The advantages of this machine are many. As the drum makes 300 revolutions in a minute, the four scutchers together make 200 strokes in the same space of time. From such power and velocity, it is evident that much work must be performed. When the horses go at the rate of two and one-third miles per hour, from three to six bolls will be thrashed; but as the quantity thrashed will be less when the straw is long than when it is short, we shall take the average at four bolls. One gentleman, whose veracity and accuracy we can depend on, assures us, that his mill thrashed 63 bolls in a day; by which, we suppose, he meant 10 hours. To prove the superior advantage of this machine to the common method of thrashing with flails, a gentleman ordered two equal quantities of oats to be thrashed by the mill and by flails. When the corn was cleaned and measured, he obtained one-sixteenth more from the sheaves thrashed by the mill than from those thrashed by the flail. We are also informed by another gentleman who has studied this machine with much attention, and calculated its advantages with care, that, independently of having the corn much cleaner separated from the straw than is usually done by flails, there is a saving of 30 or 40 per cent. in the expence of thrashing.

The number of persons requisite for attending the mill when working is six: One person drives the horses; a second hands the sheaves to a third, who unties them, while a fourth spreads them on the inclined boards and presses them gently between the rollers; a fifth person is necessary to riddle the corn as it falls from the fanners, and a sixth to remove the straw (A).

Thrashing ‖ Throne.

This machine can be moved equally well by water, wind, or horses. Mr Meikle has made such improvements on the wind-mill as to render it much more manageable and convenient than formerly; and we are informed many windmills are now erecting in different parts of the country. As to the comparative expence of these different machines, the erection of the horse machine is least; but then the expence of employing horses must be taken into consideration. One of this kind may be erected for 70l. A water-mill will cost 10l. more on account of the expence of the water-wheel. A wind-mill will cost from 200l. to 300l. sterling.

THRAVE *of Corn*, an expression denoting 24 sheaves or four shocks of six sheaves to the shock; though in some countries they only reckon 12 sheaves to the thrave.

THRASYBULUS, a renowned Athenian general and patriot, the deliverer of his country from the yoke of the 30 tyrants, lived about 294 B. C.*

* See *Attica*, N° 99—174.

THRASYMENUS LACUS, in *Ancient Geography*, a lake of Etruria, near Perusia, and not far from the Tiber, fatal to the Romans in the Punic war. Now *Il Lago de Perugia* in the Ecclesiastical State.

THREAD, a small line made up of a number of fine fibres of any vegetable or animal substance, such as flax, cotton, or silk; from which it takes its name of linen, cotton, or silk thread.

THREATENING LETTERS. Knowingly to send any letter without a name, or with a fictitious name, demanding money, or any other valuable thing, or threatening (without any demand) to kill or fire the house of any person, is made felony without benefit of clergy. And sending letters, threatening to accuse any person of a crime punishable with death, transportation, pillory, or other infamous punishment, with a view to extort from him any money or other valuable chattels, is punishable by statute 30 Geo. II. cap. 24. at the discretion of the court, with fine, imprisonment, pillory, whipping, or transportation for seven years.

THRESHING. See THRASHING.

THRIFT. See STATICE, BOTANY *Index*.

THRINAX, SMALL JAMAICA FAN-PALM, a genus of plants belonging to the class of palmæ. See BOTANY *Index*.

THRIPS, a genus of insects belonging to the order of hemiptera. See ENTOMOLOGY *Index*.

THROAT, the anterior part of an animal, between the head and the shoulders.

THROAT-WORT. See CAMPANULA, BOTANY *Index*.

THRONE, a royal seat or chair of state, enriched with ornaments of architecture and sculpture, raised on one or more steps, and covered with a kind of canopy. Such are the thrones in the rooms of audience of kings and other sovereigns.

THROSTLE.

(A) We add, on the authority of an experienced farmer, that of the six persons necessary to attend the thrashing machine, only two can in justice be charged to the account of the machine; namely, the person who manages the horses, and the one who feeds the machine: For in the usual mode of thrashing by the flail, it requires the same number of persons as the thrashing machine does to clear an equal quantity of corn from the chaff in the same manner.

THROSTLE. See TURDUS, } ORNITHOLOGY *Index*.
THRUSH. See TURDUS, }

THRUSH, or *Aphtha*. See MEDICINE *Index*.

THRYALLIS, a genus of plants belonging to the class decandria, and order of monogynia; and in the natural system ranging under the 38th order, *Tricoccæ*. See BOTANY *Index*.

THUANUS, JACOBUS AUGUSTUS, youngest son of the president de Thou, was famous for his erudition. He was born in 1553; and having finished his studies and travels, was made president a-mortier, and took possession thereof in 1595. He was employed in several important offices of state, and in reforming the university of Paris. He wrote the history of his own time in Latin, from the year 1543 to 1608, in 138 books; a work, both for subject and style, worthy of the ancients. He also left memoirs of his own life, besides poems; and died at Paris, 1617.

THUCYDIDES, a celebrated Greek historian, was born at Athens 471 B. C. He was the son of Olorus, and grandson of Miltiades, who is thought to have been descended from Miltiades the famous Athenian general, and to have married the king of Thrace's daughter. He was educated in a manner suitable to his quality, that is, in the study of philosophy and eloquence. His master in the former was Anaxagoras, in the latter Antiphon; one, by his description in the eighth book of his History, for power of speech almost a miracle, and feared by the people on that account. Suidas and Photius relate, that when Herodotus recited his history in public, a fashion in use then and many ages after, Thucydides felt so great a sting of emulation, that it drew tears from him; insomuch that Herodotus himself took notice of it, and congratulated his father on having a son who showed so wonderful an affection to the Muses. Herodotus was then 29 years of age, Thucydides about 16.

When the Peloponnesian war began to break out, Thucydides conjectured truly, that it would prove a subject worthy of his labour; and it no sooner commenced than he began to keep a journal. This explains the reason why he has attended more to chronological order than to unity of design. During the same war he was commissioned by his countrymen to relieve Amphipolis; but the quick march of Brasidas the Lacedæmonian general defeated his operations; and Thucydides, unsuccessful in his expedition, was banished from Athens. This happened in the eighth year of this celebrated war; and in the place of his banishment the general began to write an impartial history of the important events which had happened during his administration, and which still continued to agitate the several states of Greece. This famous history is continued only to the 21st year of the war; and the remaining part of the time till the demolition of the walls of Athens was described by the pen of Theopompus and Xenophon. Thucydides wrote in the Attic dialect, as being possessed of most vigour, purity, elegance, and energy. He spared neither time nor money to procure authentic materials; and the Athenians, as well as their enemies, furnished him with many valuable communications, which contributed to throw great light on the different transactions of the war. His history has been divided into eight books; the last of which is imperfect, and supposed to have been written by his daughter.

Lempriere's Dictionary.

The historian of Halicarnassus has often been compared with the son of Olorus, but each has his peculiar excellence. Sweetness of style, grace and elegance of expression, may be called the characteristics of the former; while Thucydides stands unequalled for the fire of his descriptions, the conciseness, and at the same time the strong and energetic manner of his narratives. His relations are authentic, as he himself was interested in the events he mentions; his impartiality is indubitable, as he nowhere betrays the least resentment against his countrymen, and the factious partizans of Cleon, who had banished him from Athens. The history of Thucydides was so admired by Demosthenes, that he transcribed it eight different times, and read it with such attention, that he could almost repeat it by heart. Thucydides died at Athens, where he had been recalled from his exile about 411 years B. C.

The best edition of Thucydides is that of Oxford, published in 1696, folio, and that of Duker, published at Amsterdam in 1731, folio.

THUJA, the ARBOR VITÆ; a genus of plants belonging to the class of monadelphia, and order of monœcia; and in the natural system ranging under the 51st order, *Coniferæ*. See BOTANY *Index*.

THULE, or THYLÆ, in *Ancient Geography*, an island in the most northern parts of the German ocean. Its situation was never accurately ascertained by the ancients, hence its present name is unknown by modern historians. Some suppose that it is the island now called Iceland, or part of Greenland, and others that it was *Foula*. See FOULA.

THUMB, in *Anatomy*, one of the extremities of the hand.

THUMB-Cap, an uninhabited island in the South sea, lies about seven leagues north-west of Lagoon island; it is low, woody, of a circular form, and not much above a mile in compass.

THUMMIM. See URIM.

THUNBERGIA, a genus of plants belonging to the class of didnyamia. See BOTANY *Index*.

THUNDER, the noise occasioned by the explosion of a flash of lightning echoed back from the inequalities on the surface of the earth, in like manner as the noise of a cannon is echoed, and in particular circumstances forms a rolling lengthened sound. See ELECTRICITY.

THUNDERBOLT. When lightning acts with extraordinary violence, and breaks or shatters any thing, it is called a *thunderbolt;* which the vulgar, to fit it for such effects, suppose to be a hard body, and even a stone. But that we need not have recourse to a hard solid body to account for the effects commonly attributed to the thunderbolt, will be evident to any one who considers those of the pulvis fulminans and of gunpowder; and more especially the astonishing powers of electricity. It has been supposed that meteoric stones may have given rise to the notion of a thunderbolt.

THUNDER-House. See ELECTRICITY.

THURINGIA, a division of the circle of Upper Saxony in Germany. It is a fruitful tract, abounding in corn, especially wheat; in black cattle, sheep, and horses. It is about 73 miles in length, and as much in breadth. It contains 47 towns, 14 boroughs, betwixt 700 and 800 villages, 300 noble estates, 7 superintendencies, and 5 under consistories. Thuringia, the country of the ancient Thuringi, or Catti, a branch of the

Vandals, mentioned by Tacitus, was formerly a kingdom, afterwards a county, then a landgravate, and was governed by its own princes for many ages, till 1124, when it devolved to the marquis of Misnia, and, with that country, afterwards to the duke of Saxony. But the modern Thuringia is only a part of the ancient, nay, but a part of the ancient South Thuringia, which comprehends besides, a large share of the modern Franconia, Hesse, &c. On the extinction of the male line of the ancient landgraves in 1247, it came to the margraves of Meissen, ancestors to the present electoral family. The elector has no voice in the diet, on account of his share in the landgravate or circle of Thuringia. Erfurt is the capital.

THURSDAY, the fifth day of the Christian week, but the sixth of that of the Jews.

THUS, Frankincense, a solid brittle resin, brought to us in little globes or masses, of a brownish or yellowish colour on the outside, internally whitish or variegated with whitish specks. It is supposed to be the produce of the pine that yields the common turpentine, and to concrete upon the surface of the terebinthinate juice soon after it has issued from the tree. See Incense.

THUYA. See Thuja.

THYMUS, Thyme; a genus of plants belonging to the class of didynamia, and in the natural system ranging under the 42d order, *Verticillatæ*. See Botany *Index*.

Thymus. See Anatomy *Index*.

THYRSUS, in antiquity, the sceptre which the poets put into the hand of Bacchus, and wherewith they furnished the menades in their Bacchanalia.

Thyrsus, a mode of flowering resembling the cone of a pine. It is, says Linnæus, a panicle contracted into an oval or egg-shaped form. The lower footstalks, which are longer, extend horizontally, whilst the upper ones are shorter and mount vertically. Lilac and butter-bur furnish examples.

TIARA, an ornament or habit wherewith the ancient Persians covered their head; and with which the Armenians and kings of Pontus are represented on medals; these last, because they were descended from the Persians. Latin authors call it indifferently *tiara* and *cidaris*. Strabo says the tiara was in form of a tower; and the scholiast on Aristophanes's comedy, Αχαρνης, act i. scene 2. affirms that it was adorned with peacocks feathers.

Tiara is also the name of the pope's triple crown. The tiara and keys are the badge of the papal dignity; the tiara of his civil rank, and the keys of his jurisdiction: for as soon as the pope is dead, his arms are represented with the tiara alone, without the keys. The ancient tiara was a round high cap. John XXIII. first encompassed it with a crown. Boniface VIII. added a second crown; and Benedict XII. a third.

TIARELLA, a genus of plants, belonging to the class of decandria; and in the natural system ranging under the 13th order, *Succulentæ*. See Botany *Index*.

TIBER, a great river of Italy which runs through the pope's territories, passing by Perugia and Orvietto; and having visited Rome, falls into the Tuscan sea at Ostia, 15 miles below that city.

TIBET, called by the Tartars *Barantola, Bootan*, or *Tangoot*, and by the Chinese *Tsang*, is situated between 27° and 35° north latitude; and is reckoned to be 1350 miles from east to west, and 480 from north to south. It is bounded on the north by the country of the Mongols and the desert of Kobi; on the east by China; on the west by Hindostan, and on the south by the same country and the kingdom of Ava. In the valleys lying between the lower mountains are many tribes of Indian people; and a dispute happening between the heirs of one of the rajahs or petty princes, one party called to their assistance the Boutaners, and the other the British. The latter prevailed; and the fame of British valour being carried to the court of Tibet, the Teeshoo Lama, who ruled the state under the Delai-Lama, at that time in his minority, sent a deputation to Bengal, desiring peace for the prince who had been engaged in war with the British. This was readily granted by the governor; and Mr Bogle was sent ambassador to the court of Tibet, where he resided several months; and after an absence of a year and a quarter, returned to Calcutta. The account of this gentleman's expedition hath not been published by himself; but from Mr Stewart's letter to Sir John Pringle, published in the Philosophical Transactions, vol. lxvii. we learn the following particulars, collected from his papers.

"Mr Bogle divides the territories of the Delai-Lama into two different parts. That which lies immediately contiguous to Bengal, and which is called by the inhabitants *Doopo*, he distinguishes by the name of *Bootan;* and the other, which extends to the northward as far as the frontiers of Tartary, called by the natives *Pu*, he styles *Tibet*. Bootan is ruled by the Dah Terriah, or Deb Rajah. It is a country of steep and inaccessible mountains, whose summits are crowned with eternal snow; they are intersected with deep valleys, through which pour numberless torrents that increase in their course, and at last, gaining the plains, lose themselves in the great rivers of Bengal. These mountains are covered down their sides with forests of stately trees of various sorts; some (such as pines, &c.) which are known in Europe; others, such as are peculiar to the country and climate. The valleys and sides of the hills which admit of cultivation are not unfruitful, but produce crops of wheat, barley, and rice. The inhabitants are a stout and warlike people, of a copper complexion, in size rather above the middle European stature, hasty and quarrelsome in their temper, and addicted to the use of spirituous liquors; but honest in their dealings, robbery by violence being almost unknown among them. The chief city is Tassey Seddein, situated on the Patchoo. Tibet begins properly from the top of the great ridge of the Caucasus, and extends from thence in breadth to the confines of Great Tartary, and perhaps to some of the dominions of the Russian empire. The woods, which everywhere cover the mountains in Boutan, are here totally unknown; and, except a few straggling trees near the villages, nothing of the sort is to be seen. The climate is extremely severe and rude. At Chamnanning, where he wintered, although it be in latitude 31° 39′, only 8° to the northward of Calcutta, he often found the thermometer in his room at 29° by Fahrenheit's scale; and in the middle of April the standing waters were all frozen, and heavy showers of snow perpetually fell. This, no doubt, must be owing to the great elevation of the country, and to the vast

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vast frozen space over which the north wind blows uninterrupted from the pole, through the vast deserts of Siberia and Tartary, till it is stopped by this formidable wall.

"The Tibetians are of a smaller size than their southern neighbours, and of a less robust make. Their complexions are also fairer, and many of them have even a ruddiness in their countenances unknown to the other climates of the east. Those whom Mr Bogle saw at Calcutta appeared to have quite the Tartar face. They are of a mild and cheerful temper; the higher ranks are polite and entertaining in conversation, in which they never mix either strained compliments or flattery. The common people, both in Bootan and Tibet are clothed in coarse woollen stuffs of their own manufacture, lined with such skins as they can procure: but the better orders of men are dressed in European cloth, or China silk, lined with the finest Siberian furs. The use of linen is totally unknown among them. The chief food of the inhabitants is the milk of their cattle, prepared into cheese, butter, or mixed with the flour of a coarse barley or of pease, the only grain which their soil produces; and even these articles are in a scanty proportion: but they are furnished with rice and wheat from Bengal and other countries in their neighbourhood. They also are supplied with fish from the rivers in their own and the neighbouring provinces, salted and sent into the interior parts. They have no want of animal food from the cattle, sheep, and hogs, which are raised on their hills; and are not destitute of game. They have a singular method of preparing their mutton, by exposing the carcase entire, after the bowels are taken out, to the sun and bleak northern winds which blow in the months of August and September, without frost, and so dry up the juices and parch the skin, that the meat will keep uncorrupted for the year round. This they generally eat raw, without any other preparation.

"The religion and political constitution of this country, which are intimately blended together, would make a considerable chapter in its history. It suffices to say, that at present, and ever since the expulsion of the Eluth Tartars, the kingdom of Tibet is regarded as depending on the empire of China, which they call *Cathay;* and there actually reside two mandarins, with a garrison of a thousand Chinese, at Lahassa the capital, to support the government; but their power does not extend far: and in fact the Lama, whose empire is founded on the surest grounds, personal affection and religious reverence, governs every thing internally with unbounded authority. Every body knows that the Delai Lama is the great object of adoration for the various tribes of heathen Tartars, who roam through the vast tract of continent which stretches from the banks of the Volga to Correa on the sea of Japan, the most extensive religious dominion, perhaps, on the face of the globe. See LAMA.

"It is an old notion, that the religion of Tibet is a corrupted Christianity; and even Father Disederii, a Jesuit (but not of the Chinese mission) who visited the country about the beginning of this century, thinks he can resolve all their mysteries into ours; and asserts, with a truly mystical penetration, that they have certainly a good notion of the Trinity, since in their address to the Deity, they say as often *konciok-oik* in the plural as *konciok* in the singular, and with their rosaries pronounce these words *om*, *ha*, *hum*. The truth is, that the religion of Tibet, from whatever source it sprung, is pure and simple in its source, conveying very exalted notions of the Deity, with no contemptible system of morality: but in its progress it has been greatly altered and corrupted by the inventions of worldly men; a fate we can hardly regret in a system of error, since we know that that of truth has been subject to the same. Polygamy, at least in the sense we commonly receive the word, is not in practice among them; but it exists in a manner still more repugnant to European ideas; for there is a plurality of husbands, which is firmly established and highly respected there. In a country where the means of subsisting a family are not easily found, it seems not impolitic to allow a set of brothers to agree in raising one, which is to be maintained by their joint efforts. In short, it is usual in Tibet for the brothers in the family to have a wife in common, and they generally live in great harmony and comfort with her; not but sometimes little dissensions will arise (as may happen in families constituted upon different principles), an instance of which Mr Bogle mentions in the case of a modest and virtuous lady, the wife of half a dozen of the Teeshoo Lama's nephews, who complained to the uncle that the two youngest of her husbands did not furnish that share of love and benevolence to the common stock which duty and religion required of them. In short, however strange this custom may appear to us, it is an undoubted fact that it prevails in Tibet.

"The dead are exposed on the pinnacle of some neighbouring mountain, to be devoured by wild beasts and birds of prey, or wasted away by time and the vicissitudes of the weather in which they lie. The mangled carcases and bleached bones lie scattered about; and amidst this scene of horror, some miserable old wretch, man or woman, lost to all feelings but those of superstition, generally sets up an abode, to perform the dismal office of receiving the bodies, assigning each a place, and gathering up the remains when too widely dispersed."

To the account of Tibet which we have given from the communications of Mr Bogle, we may add the information which we have obtained from a later traveller, Mr Saunders * surgeon at Boglepoer in Bengal, who made a journey into Tibet in the year 1783. His observations chiefly respect the natural productions and diseases of the country.

* Paper in the *Phil. Trans.* vol. lxxix.

The plants which Mr Saunders found were almost all European plants, a great number of them being natives of Britain. From the appearance of the hills he concludes that they must contain many ores of metal and pyrites. There are inexhaustible quantities of tincal or borax, and rock-salt is plentiful; gold-dust is found in great quantities in the beds of rivers, and sometimes in large masses, lumps and irregular veins; lead, cinnabar containing a large proportion of quicksilver, copper, and iron, he thinks might easily be procured. But the inhabitants of Tibet have no better fuel than the dung of animals. A coal mine would be a valuable discovery. We are told, that in some parts of China bordering on Tibet coal is found and used as fuel.

It is remarkable that the same disease prevails at the foot

foot of the mountains of Tibet as in Switzerland at the foot of the Alps, a glandular swelling in the throat commonly called *goitre*.

The language spoken in Tibet is different from that of the Tartars. The astronomers are acquainted with the motion of the heavenly bodies, and able to calculate eclipses; but the lamas are generally ignorant; few of them can read, much less understand their antient books. See ASIA, SUPPLEMENT.

TIBULLUS, AULUS ALBIUS, a Roman knight, and a celebrated Latin poet, was born at Rome 43 B. C. He was the friend of Horace, Ovid, Macer, and other great men in the reign of Augustus. He accompanied Messala Corvinus in his expedition against the island of Corcyra: but falling sick, and being unable to support the fatigues of war on account of the weakness of his constitution, he quitted the profession of arms, and returned to Rome, where he died before the year 17; when Ovid showed his grief for his death by writing a fine elegy upon him. Tibullus wrote four books of elegies, which are still extant: they are written in a tender and agreeable style, and in very elegant Latin. Muret and Joseph Scaliger have written learned and curious commentaries on the works of this poet. The best edition of Tibullus is that of Janus Bronckhusius, published at Amsterdam in 1708, in one volume quarto. We have an English poetical version by Mr Grainger.

TIBUR, in *Ancient Geography*, a town of Latium, pleasantly situated on the Anio. Here Horace had his villa and house; and here he wished to end his days. Here Adrian built an extraordinary villa called *Tiburtina*, inscribed with the names of the provinces and of the most considerable places, (Spartian); near which Zenobia had a house called *Zenobia*, (Trebellius, Pollio). Hither Augustus often retreated on account of its salubrity, (Suetonius): for which it is greatly recommended (Martial). Anciently, when the Romans had far extended their territory, it was the utmost place of banishment, (Ovid). It had a temple of Hercules; and therefore called *Herculeum*. In the temple was a library, (A. Gellius). Now *Tivoli* in the Campagna di Roma, on the Teverone.

TICINUS, in *Ancient Geography*, a river in Insubria, rising in Mount Adula, traversing the Lacus Verbanus southwards, and falling into the Po near Ticinum. Between this river and the Po Hannibal gained his first victory over the Romans under P. Scipio. The general himself escaped with the utmost difficulty, and that by the bravery of his son the first Scipio Africanus. Now the *Tesino*, rising in Mount Godard, running south through the Lago Maggiore and Milan, by Pavia, into the Po.

TICK. See ACARUS, ENTOMOLOGY *Index*.

TICKELL, THOMAS, an excellent English poet, was the son of the Reverend Richard Tickell, and was born in 1686, at Bridekirk in Cumberland. He was educated at Queen's college, Oxford, of which he was made fellow; and while he continued at that university, he addressed to Mr Addison a complimentary copy of verses on his Opera of Rosamond, which introduced him to an acquaintance with that gentleman, who discovering his merit, became his sincere friend. On Mr Addison being made secretary of state, he appointed Mr Tickell his under-secretary; and on his being obliged to resign that office on account of his ill-health, he recommended him so effectually to Mr Craggs his successor, that he was continued in his post till that gentleman's death. In 1724, Mr Tickell was appointed secretary to the lords justices in Ireland, and enjoyed that place as long as he lived. He wrote some poems, which, when separately published, met with a favourable reception, and passed through several editions: they are now printed in the second volume of the Minor Poets. After Mr Addison's death Mr Tickell had the care of the edition of his works printed in 4 vols. 4to; to which he prefixed an account of Mr Addison's life, and a poem on his death. Mr Tickell died in the year 1740.

TICKERA, a considerable article of merchandise in Fezzan in Africa; it is valued by travellers as a portable and highly salubrious food. It is a preparation of pounded dates, and the meal of Indian corn, formed into a paste, and highly dried in an oven.

TICKSEED, SUN-FLOWER. See COREOPSIS, BOTANY *Index*.

TICUNAS. See POISON.

TIDE, is a word which expresses that rising and falling of the waters which are observed on all maritime coasts.

There is a certain depth of the waters of the ocean which would obtain if all were at rest: but observation shows that they are continually varying from this level, and that some of these variations are regular and periodical.

1*st*, It is observed, that on the shores of the ocean, and in bays, creeks, and harbours, which communicate freely with the ocean, the waters rise up above this mean height twice a-day, and as often sink below it, forming what is called a FLOOD and an EBB, a HIGH and LOW WATER. The whole interval between high and low water is called a TIDE; the water is said to FLOW and to EBB; and the rising is called the FLOOD TIDE, and the falling is called the EBB TIDE.

2*d*, It is observed, that this rise and fall of the waters is variable in quantity. At Plymouth, for instance, it is sometimes 21 feet between the greatest and least depth of the water in one day, and sometimes only 12 feet.

These different heights of tide are observed to succeed each other in a regular series, diminishing from the greatest to the least, and then increasing from the least to the greatest. The greatest is called a SPRING TIDE, and the least is called a NEAP TIDE.

3*d*, This series is completed in about 15 days. More careful observation shows that two series are completed in the exact time of a lunation. For the spring tide in any place is observed to happen precisely at a certain interval of time (generally between two and three days) after new or full moon; and the neap tide at a certain interval after half moon: or, more accurately speaking, it is observed that the spring tide always happens when the moon has got a certain number of degrees eastward of the line of conjunction and opposition, and the neap tide happens when she is a certain number of degrees from her first or last quadrature. Thus the whole series of tides appears to be regulated by the moon.

4*th*, It is observed that high water happens at new and full moon, when the moon has a certain determined position with respect to the meridian of the place of observation, preceding or following the moon's

southing

southing a certain interval of time; which is constant with respect to the place, but very different in different places.

5th, The time of high water in any place appears to be regulated by the moon; for the interval between the time of high water and the moon's southing never changes above three quarters of an hour, whereas the interval between the time of high water and noon changes six hours in the course of a fortnight.

6th, The interval between two succeeding high waters is variable. It is least of all about new and full moon, and greatest when the moon is in her quadratures. As two high waters happen every day, we may call the double of their interval a TIDE DAY, as we call the diurnal revolution of the moon a *lunar day*. The tide is shortest about new and full moon, being then about $24^h\ 37'$; about the time of the moon's quadratures it is $25^h\ 27'$. These values are taken from a mean of many observations made at Barbadoes by Dr Maskelyne.

7th, The tides in similar circumstances are greatest when the moon is at her smallest distance from the earth, or in her perigee, and, gradually diminishing, are smallest when she is in her apogee.

8th, The same remark is made with respect to the sun's distance, and the greatest tides are observed during the winter months of Europe.

9th, The tides in any part of the ocean increase as the moon, by changing her declination, approaches the zenith of that place.

10th, The tides which happen while the moon is above the horizon are greater than the tides of the same day when the moon is below the horizon.

Such are the regular phenomena of the tides. They are important to all commercial nations, and have therefore been much attended to. It is of the tides, in all probability, that the Bible speaks, when God is said to set bounds to the sea, and to say, "thus far shall it go, and no farther."

Homer is the earliest profane author who speaks of the tides. Indeed it is not very clear that it is of them that he speaks (in the 12th book of the Odyssey) when he speaks of Charybdis, which rises and retires thrice in every day. Herodotus and Diodorus Siculus speak more distinctly of the tides in the Red sea. Pytheas of Marseilles is the first who says any thing of their cause. According to Strabo he had been in Britain, where he must have observed the tides of the ocean. Plutarch says expressly that Pytheas ascribed them to the moon. It is somewhat wonderful that Aristotle says so little about the tides. The army of Alexander, his pupil, were startled at their first appearance to them near the Persian gulf; and we should have thought that Aristotle would be well informed of all that had been observed there. But there are only three passages concerning them in all Aristotle's writings, and they are very trivial. In one place he speaks of great tides observed in the north of Europe; in another, he mentions their having been ascribed by some to the moon; and in a third, he says, that the tide in a great sea exceeds that in a small one. The Greeks had little opportunity of observing the tides. The conquests and the commerce of the Romans gave them more acquaintance with them. Cæsar speaks of them in the 4th book of his Gallic War. Strabo, after Posidonius, classes the phenomena into daily, monthly, and annual. He observes, that the sea rises as the moon gets near the meridian, whether above or below the horizon, and falls again as she rises or falls; also, that the tides increase at the time of new and full moon, and are greatest at the summer solstice. Pliny explains the phenomena at some length; and says, that both the sun and moon are their cause, dragging the waters along with them (B. II. c. 97.). Seneca (*Nat. Quest.* III. 28.) speaks of the tide with correctness; and Macrobius (*Somn. Scip.* I. 6.) gives a very accurate description of their motions.

It is impossible that such phenomena should not exercise human curiosity as to their cause. Plutarch (*Plut. Phil.* III. 17.), Galileo (*Syst. Mund.* Dial. 4.), Riccioli in his *Almagest*, ii. p. 374, and Gassendi, ii. p. 27. have collected most of the notions of their predecessors on the subject; but they are of so little importance, that they do not deserve our notice. Kepler speaks more like a philosopher (*De Stella Martis*, and *Epit. Astron.* p. 555.). He says that all bodies attract each other, and that the waters of the ocean would all go to the moon were they not retained by the attraction of the earth; and then goes on to explain their elevation under the moon and on the opposite side, because the earth is less attracted by the moon than the nearer waters, but more than the waters which are more remote.

The honour of a complete explanation of the tides was reserved for Sir Isaac Newton. He laid hold of this class of phenomena as the most incontestable proof of universal gravitation, and has given a most beautiful and synoptical view of the whole subject; contenting himself, however, with merely exhibiting the chief consequences of the general principle, and applying it to the phenomena with singular address. But the wide steps taken by this great philosopher in his investigation leave ordinary readers frequently at fault: many of his assumptions require the greatest mathematical knowledge to satisfy us of their truth. The academy of Paris therefore proposed to illustrate this among other parts of the principles of natural philosophy, and published the theory of the tides as a prize problem. This produced three excellent dissertations by M'Laurin, Daniel Bernoulli, and Euler. Aided by these, and chiefly by the second, we shall here give a physical theory, and accommodate it to the purposes of navigation by giving the rules of calculation. We have demonstrated in our dissertations on the physical principles of the celestial motions, that it is an unexcepted fact, that every particle of matter in the solar system is actually deflected toward every other particle; and that the deflection of a particle of matter toward any distant sphere is proportional to the quantity of matter in that sphere directly, and to the square of the distance of the particle from the centre of that sphere inversely: and having found that the heaviness of a piece of terrestrial matter is nothing but the supposed opponent to the force which we exert in carrying this piece of matter, we conceive it as possessing a property, that is, distinguishing quality, manifested by its being *gravis* or heavy. This is heaviness, *gravitas*, gravity; and the manifestation of this quality, or the event in which it is seen, whether it be directly falling, or deflected in a parabolic curve, or stretching a coiled spring, or breaking a rope, or simply pressing on its support, is *gravitatio*, gravitation; and the body is said to gravitate. When all obstacles are removed from the body,

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body, as when we cut the string by which a stone is hung, it moves directly downwards, *tendit ad terram. Si discindatur funis tenderet lapis ad terram. Dum vero funis integer perstet, lapis terram versus niti censetur.* By some metaphysical process, which it is needless at present to trace, this *nisus ad motum* has been called a *tendency* in our language. Indeed the word has now come to signify the energy of any active quality in those cases where its simplest and most immediate manifestation is prevented by some obstacle. The stone is now said to tend towards the earth, though it does not actually approach it, being withheld by the string. The stretching the string in a direction perpendicular to the horizon is conceived as a full manifestation of this tendency. This tendency, this energy of its heaviness, is therefore named by the word which distinguishes the quality; and it is called *gravitation*, and it is said to *gravitate*.

But Sir Isaac Newton discovered that this deflection of a heavy body differs in no respect from that general deflection observed in all the bodies of the solar system. For 16 feet, which is the deflection of a stone in one second, has the very same proportion to $\frac{1}{20}$th of an inch, which is the simultaneous deflection of the moon, that the square of the moon's distance from the centre of the earth has to the square of the stone's distance from it, namely, that of 3600 to 1.

Thus we are enabled to compare all the effects of the mutual tendencies of the heavenly bodies with the tendency of gravity, whose effects and measures are familiar to us.

If the earth were a sphere covered to a great depth with water, the water would form a concentric spherical shell; for the gravitation of every particle of its surface would then be directed to the centre, and would be equal. The curvature of its surface therefore would be every where the same, that is, it would be the uniform curvature of a sphere.

Plate DXXXVI. fig. 1.

It has been demonstrated in former articles, after Sir Isaac Newton, that the gravitation of a particle C (fig. 1.) to the centre O, is to that of a particle E at the surface as CO to EO. In like manner the gravitation of o is to that of p as o to p O. If therefore EO and O p are two communicating canals, of equal lengths, the water in both would be in equilibrio, because each column would exert the same total pressure at O. But if the gravitation of each particle in p O be diminished by a certain proportion, such as $\frac{1}{100}$th of its whole weight, it is plain that the total pressure of the column p O will be $\frac{1}{100}$th part less than that of the column EO. Therefore they will no longer be in equilibrio. The weight of the column EO will prevail; and if a hollow tower P p be built at the mouth of the pit p o, the water will sink in EO and rise in O p, till both are again in equilibrio, exerting equal total pressures at O. Or we may prevent the sinking at E by pouring in more water into the tower P p. The same thing must happen in the canal fc perpendicular to EO, if the gravitation of every particle be diminished by a force acting in the direction CF, and proportional to the distance of the particle from C, and such, that when c C is equal to o O, the force acting on c is equal to the force acting on o. In order that the former equilibrium may be restored after this diminution of the gravitation of the column fC, it is plain that more water must be poured into the oblique tower f F. All this is evident when we consider the matter hydrostatically. The gravitation of the particle c may be represented by o O; but the diminution of the pressure occasioned by this at O is represented by C c.

Hence we can collect this much, that the whole diminution of pressure at C is to the whole diminution of pressure at O as the sum of all the lines c C to the sum of all the lines o O, that is, as $f\,C^2$ to PO^2. But the weight of the small quantity of water added in each tower is diminished in the same proportion; therefore the quantity added at F f must be to the quantity added at P p as fC to p O. Therefore we must have Ff: P p=fC : p O, and the points E, F, P, must be in the circumference of an ellipse, of which PO and EO are the transverse and conjugate semi-axes.

What we have here supposed concerning the diminution of gravity in these canals is a thing which really obtains in nature. It was demonstrated, when treating of the *Precession of the Equinoxes*, that if the sun or moon lie in the direction OP, at a very great distance, there results from the unequal gravitation of the different particles of the earth a diminution of the gravity of each particle; which diminution is in a direction parallel to OP, and proportional to the distance of the particle from a plane passing through the centre of the earth at right angles to the line OP.

Thus it happens that the waters of the ocean have their equilibrium disturbed by the unequal gravitation of their different particles to the sun or to the moon; and this equilibrium cannot be restored till the waters come in from all hands, and rise up around the line joining the centres of the earth and of the luminary. The spherical ocean must acquire the form of a prolate spheroid generated by the revolution of an ellipse round its transverse axis. The waters will be highest in that place which has the luminary in its zenith, and in the antipodes to that place; and they will be most depressed in all those places which have the luminary in their horizon. P and P′ will be the poles, and EOQ will be the equator of this prolate spheroid.

Mr Ferguson, in his Astronomy, assigns another cause of this arrangement, viz. the difference of the centrifugal forces of the different particles of water, while the earth is turning round the common centre of gravity of the earth and moon. This, however, is a mistake. It would be just if the earth and moon were attached to the ends of a rod, and the earth kept always the same face toward the moon.

It is evident that the accumulation at P and P′, and the depression at the equator, must augment and diminish in the same proportion with the disturbing force. It is also evident that its absolute quantity may be discovered by our knowledge of the proportion of the disturbing force to the force of gravity.—Now this proportion is known; for the proportion of the gravitation of the earth's centre to the sun or moon, to the force of gravity at the earth's surface, is known; and the proportion of the gravitation of the earth's centre to the luminary, to the difference of the gravitations of the centre and of the surface, is also known, being very nearly the proportion of the distance of the luminary to twice the radius of the earth.

Although this reasoning, by which we have ascertained the elliptical form of the watery spheroid, be sufficiently

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ciently convincing, it is very imperfect, being accommodated to one condition only of equilibrium, viz. the equilibrium of the canals fc and co. There are several other conditions equally necessary to which this lax reasoning will not apply, such as the direction of the whole remaining gravitation in any point F. This must be perpendicular to the surface, &c. &c. Nor will this mode of investigation ascertain the eccentricity of the spheroid without a most intricate process. We must therefore take the subject more generally, and show the proportion and directions of gravity in every point of the spheroid. We need not, however, again demonstrate that the gravitation of a particle placed any where without a perfect spherical shell, or a sphere consisting of concentric spherical shells, either of uniform density, or of densities varying according to some function of the radius, is the same as if the whole matter of the shell or sphere were collected in the centre. This has been demonstrated in the article ASTRONOMY. We need only remind the reader of some consequences of this theorem which are of continual use in the present investigation.

1. The gravitation to a sphere is proportional to its quantity of matter directly, and to the square of the distance of its centre from the gravitating particle inversely.

2. If the spheres be homogeneous and of the same density, the gravitations of particles placed on their surfaces, or at distances which are proportional to their diameters, are as the radii; for the quantities of matter are as the cubes of the radii, and the attractions are inversely as the squares of the radii; and therefore the whole gravitations are as $\frac{r^3}{r^2}$, or as r.

3. A particle placed within a sphere has no tendency to the matter of the shell which lies without it, because its tendency to any part is balanced by an opposite tendency to the opposite part. Therefore,

4. A particle placed any where *within* a homogeneous sphere gravitates to its centre with a force proportional to its distance from it.

It is a much more difficult problem to determine the gravitation of particles to a spheroid. To do this in general terms, and for every situation of the particle, would require a train of propositions which our limits will by no means admit; we must content ourselves with as much as is necessary for merely ascertaining the ratio of the axes. This will be obtained by knowing the ratio of the gravitation at the pole to that at the equator. Therefore,

Fig. 2. Let NmSqN (fig. 2.) be a section through the axis of an oblate homogeneous spheroid, which differs very little from a sphere. NS is the axis, mq is the equatorial diameter, O is the centre, and NMSQ is the section of the inscribed sphere. Let P be a particle situated at any distance without the sphere in its axis produced; it is required to determine the gravitation of this particle to the whole matter of the spheroid?

Draw two lines PAC, PBD, very near to each other, cutting off two small arches AB, CD; draw GAa, HBb, ICc, KDd, perpendicular to the axis; also draw OE and AL perpendicular to PAC, and OF perpendicular to PD, cutting PC in f. Join OA.

Let OA, the radius of the inscribed sphere, be r, and OP the distance of the gravitating particle be d, and Mm, the elevation of the equator of the spheroid, or the ellipticity, be e. Also make AE $= x$, and OE$=y$, $=\sqrt{r^2-x^2}$. Then AE—BF$=\dot{x}$ and F$f$$=\dot{y}$, $=-\frac{x\dot{x}}{\sqrt{r^2-x^2}}$.

Tide.

Suppose the whole figure to turn round the axis OP. The little space ABba will generate a ring of the redundant matter; so will CDdc. This ring may be considered as consisting of a number of thin rings generated by the revolution of Aa. The ring generated by Aa is equal to a parallelogram whose base is the circumference described by A, and whose height is Aa. Therefore let c be the circumference of a circle whose radius is 1. The ring will be A$a \times c \times$AG. But because maN is an arch of an ellipse, we have Mm : Aa = MO : AG$=r$: AG, and Aa=M$m \times \frac{\text{AG}}{r}$, $=\frac{e}{r}$ AG. Therefore the surface of this ring is $= c\frac{e}{r}\,\text{AG}^2$.

We have supposed the spheroid to be very nearly spherical, that is, e exceedingly small in comparison of r. This being the case, all the particles in Aa, and consequently all the particles in the ring generated by the revolution of Aa, will attract the remote particle P with the same force that A does very nearly. We may say the same thing of the whole matter of the ring generated by the revolution of ABba. This attraction is exerted in the direction PA by each individual particle. But every action of a particle A is accompanied by the action of a particle A′ in the direction PA′. These two compose an attraction in the direction PO. The whole attraction in the directions similar to PA is $= c \times \frac{e}{r} \frac{\text{AG}^2}{\text{PA}^2} \times$GH, for GH measures the number of parallel plates of which the solid ring is composed. This being decomposed in the direction PG is $= c \times \frac{e}{r} \times \frac{\text{AG}^2 \cdot \text{PG}}{\text{PA}^3} \times$GH. But $\frac{\text{AG}^2}{\text{PA}^2} = \frac{\text{OE}^2}{\text{PO}^2}$, and $\frac{\text{PG}}{\text{PA}} = \frac{\text{PE}}{\text{PO}}$. Therefore the attraction of the ring, estimated in the direction PO, is $= c \times \frac{e}{r} \times \frac{\text{OE}^2 \cdot \text{PE}}{\text{PO}^3} \times$GH.

Further, by the nature of the circle, we have HG : AB=AG : AO; also AB : BL=AO : OE. But PA : AG=PO : OE, and OE $= \frac{\text{AG} \times \text{PO}}{\text{PA}}$. Therefore

AB : BL=AO : $\frac{\text{AG . PO}}{\text{PA}}$, =AO . PA : PO . AG

Also BL : LA=EO : EA,

And LA : Ff= PA : Pf, = ultimately PA : PE.

Therefore, by equality, HG : Ff, =AG . AO . PA. EO . PA : AO . PO . AG . EA . PE.

Or HG : Ff=EO . PA² : PO . EA . PE.

and HG$=$F$f \times \frac{\text{EO . PA}^2}{\text{PO . PE . EA}}$.

Now substitute this value of HG in the formula expressing the attraction of the ring. This changes it to $c\frac{e}{r} \times \frac{\text{OE}^2\text{. PE}}{\text{PO}^3} \times \frac{\text{OE . PA}^2}{\text{PO . PE . EA}} \times$F$f$, or $c\frac{e}{r} \times \frac{\text{OE}^3\text{. PA}^2}{\text{PO}^4\text{. EA}} \times$ Ff. In like manner, the attraction of

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the ring generated by the revolution of CD $\dot{d}c$ is $c\frac{e}{r} \times \frac{OE^3 . PC^2}{PO^4 . EA} \times Ff$. Therefore the attraction of both is $= c\frac{e}{r} \times Ff \times \frac{OE^3}{PO^4.EA} \times \overline{PA^2 + PC^2}, = c\frac{e}{r} \times Ff \frac{y^3}{d^4 . x} \times \overline{PA^2 + PC^2}$. But $PA^2 + PC^2 = 2\,PE^2 + 2\,EA^2 = 2\,PE^2 + 2\,x^2$. Therefore the attraction is $2c\frac{e}{r\,d^4} \times Ff\frac{y^3}{x} \times \overline{PE^2 + x^2}$. But $Ff = \dot{y}, = \frac{x}{y}\dot{x}$. Therefore $Ff\frac{y^3}{x} = \frac{x}{y}\dot{x} \times \frac{y^3}{x}, = y^2\dot{x}, = \overline{r^2 - x^2}\,\dot{x}$.

Therefore the attraction of the two rings is $2c\frac{e}{r\,d^4} \times \overline{r^2 - x^2} \times \overline{PE^2 + x^2} \times \dot{x}$. But $PE^2 = PO^2 - OE^2, = d^2 - (r^2 - x^2) = d^2 - r^2 + x^2$ Therefore the attraction of the two rings is

$$2c\frac{e}{r\,d^4} \times \overline{r^2 - x^2} \times \overline{d^2 - r^2 + 2x^2}\,\dot{x}, = 2c\frac{e}{r\,d^4} \times \overline{r^2 d^2 \dot{x} - r^4\dot{x} + 2r^2x^2\dot{x} - d^2x^2\dot{x} + r^2x^2\dot{x} - 2x^4\dot{x}} = 2c\frac{e}{r\,d^4} \times \overline{r^2d^2\dot{x} + 3r^2x^2\dot{x} - r^4\dot{x} - d^2x^2\dot{x} - 2x^4\dot{x}}.$$

The attraction of the whole shell of redundant matter will be had by taking the fluent of this formula, which is

$$2c\frac{e}{rd^4} \times \left(r^2d^2x + \frac{3r^2x^3}{3} - r^4x - \frac{d^2x^3}{3} - \frac{2x^5}{5}\right),$$

and then make $x = r$. This gives $2c\frac{e}{r\,d^4}(d^2r^3 + r^5 - r^5 - \frac{1}{3}d^2r^3 - \frac{2}{5}r^5)$, which is $= 2c\frac{e}{r\,d^4}(\frac{2}{3}d^2r^3 - \frac{2}{5}r^5)$, $= \frac{4cer^2}{3d^2} - \frac{4r^2}{5d^4}$. To this add the attraction of the inscribed sphere, which is $\frac{2}{3}\frac{cr^3}{d^2}$, and we have the attraction of the whole spheroid

$$= \frac{2}{3}\frac{cr^3}{d^2} + \frac{4}{3}\frac{cer^2}{d^2} - \frac{4}{5}\frac{cer^4}{d^4}.$$

Cor. 1. If the particle P is situated precisely in N, the pole of the spheroid, the attraction of the spheroid is $\frac{2}{3}cr + \frac{8}{15}ce$.

If the spheroid is not oblate, but oblong, and if the greater semiaxis be r, and the depression at the equator be e, the analysis is the same, taking e negatively. Therefore the attraction for a particle in the pole, or the gravitation of a particle in the pole, is $\frac{2}{3}cr - \frac{8}{15}ce$.

But if the polar semiaxis be $r + e$, and the equatorial radius be r, so that this oblong spheroid has the same axis with the former oblate one, the gravitation of a particle in the pole is $\frac{2}{3}cr + \frac{2}{15}ce$.

Cor. 2. If a number of parallel planes are drawn perpendicular to the equator of an oblong spheroid, whose longer semiaxis is $r + e$, and equatorial radius r, they will divide the spheroid into a number of similar ellipses; and since the ellipse through the axis has $r + e$ and r for its two semiaxes, and the radius of a circle of equal area with this ellipse is a mean proportional between r and $r + e$, and therefore very nearly $= r + \frac{1}{2}e$, when e is very small in comparison of r, a particle on the equator of the oblong spheroid will be as much attracted by these circles of equal areas, with their corresponding ellipses, as by the ellipses. Now the attraction at the pole of an oblate spheroid was $\frac{2}{3}cr + \frac{8}{15}ce$. Therefore putting $\frac{1}{2}e$ in place of e, the attraction on the equator of the oblong spheroid will be equal to $\frac{2}{3}cr + \frac{4}{15}ce$.

Thus we have ascertained the gravitations of a particle situated in the pole, and of one situated in the equator, of a homogeneous oblong spheroid. This will enable us to solve the following problem:

If the particles of a homogeneous oblong fluid spheroid attract each other with a force inversely as the squares of their distances, and if they are attracted by a very distant body by the same law, and if the ratio of the equatorial gravity to this external force be given; to find what must be the proportion of the semiaxis, so that all may be in equilibrio, and the spheroid preserve its form?

Let r be the equatorial radius, and $r + e$ be the polar semiaxis. Then the gravitation at the pole m is $\frac{2}{3}cr + \frac{2}{15}ce$, and the gravitation at the equator is $\frac{2}{3}cr + \frac{4}{15}ce$. Now by the gravitation towards the distant body placed in the direction of the polar axis, the polar gravitation is diminished, and the equatorial gravitation is increased; and the increase of the equatorial gravitation is to the diminution of the polar gravitation as NO to 2 m O. Therefore if the whole attraction of the oblong spheroid for a particle on its equator be to the force which the distant body exerts there, as G to P, and if the spheroid is very nearly spherical, the absolute weight at the equator will be $\frac{2}{3}cr + \frac{4}{15}ce + \frac{2}{3}cr\frac{P}{G}$. And the absolute weight at the pole will be $\frac{2}{3}cr + \frac{2}{15}ce - \frac{2}{3}cr\frac{2P}{G}$. Their difference is $\frac{2}{15}ce + 2cr\frac{P}{G}$.

Now if we suppose this spheroid to be composed of similar concentric shells, all the forces will decrease in the same ratio. Therefore the weight of a particle in a column reaching from the equator to the centre will be to the weight of a similarly situated particle of a column reaching from the pole to the centre, as the weight of a particle at the equator to the weight of a particle at the pole. But the whole weights of the two columns must be equal, that they may balance each other at the centre. Their lengths must therefore be reciprocally as the weights of similarly situated particles; that is, the polar semiaxis must be to the equatorial radius, as the weight of a particle at the equator to the weight of a particle at the pole. Therefore we must have $\frac{2}{15}ce + 2cr\frac{P}{G} : \frac{2}{3}cr + \frac{2}{15}ce - \frac{4}{3}cr\frac{P}{G} = e : r$.

Hence we derive $2r\frac{P}{G} = \frac{8}{15}e$, or $4\,G : 15\,P = r : e$.

This determines the form of the fluid spheroid when the ratio of G to P is given.

It is well known that the gravitation of the moon to the earth is to the disturbing force of the sun as 178,725 to 1 very nearly. The lunar gravitation is increased as she approaches the earth in the reciprocal duplicate ratio of the distances. The disturbing force of the sun diminishes in the simple ratio of the distances; therefore the weight of a body on the surface of the earth is to the disturbing

disturbing force of the sun on the same body in a ratio compounded of the ratio of 178,725 to 1, the ratio of 3600 to 1, and the ratio of 60 to 1; that is, in the ratio of 38604600 to 1. If the mean radius of the earth be 20934500 feet, the difference of the axis, or the elevation of the pole of the watery spheroid produced by the gravitation to the sun, will be $\frac{15}{4} \times \frac{20934500}{38604600}$ feet, or very nearly $24\frac{1}{2}$ inches. This is the tide produced by the sun on a homogeneous fluid sphere.

It is plain, that if the earth consists of a solid nucleus of the same density with the water, the form of the solar tide will be the same. But if the density of the nucleus be different, the form of the tide will be different, and will depend both on the density and on the figure of the nucleus.

If the nucleus be of the same form as the surrounding fluid, the whole will still maintain its form with the same proportion of the axis. If the nucleus be spherical, its action on the surrounding fluid will be the same as if all the matter of the nucleus by which it exceeds an equal bulk of the fluid were collected at the centre. In this case, the ocean cannot maintain the same form: for the action of this central body being proportional to the square of the distance inversely, will augment the gravity of the equatorial fluid more than it augments that of the circumpolar fluid; and the ocean, which was in equilibrio (by supposition), must now become more protuberant at the poles. It may, however, be again balanced in an elliptical form, when it has acquired a just proportion of the axes. The process for determining this is tedious, but precisely similar to the preceding.

If the density of the nucleus exceed that of the fluid about $\frac{1}{5\frac{1}{2}}$, we shall have $r : e = G : 3\,P$, which is nearly the form which has been determined for the earth, by the mensuration of degrees of the meridian, and by the vibration of pendulums. The curious reader will do well to consult the excellent dissertations by Clairaut and Boscovich on the Figure of the Earth, where this curious problem is treated in the most complete manner. Mr Bernoulli, in his dissertation on the Tides, has committed a great mistake in this particular. On the other hand, if the nucleus be less dense than the waters, or if there be a great central hollow, the elevation produced by the sun will exceed $24\frac{1}{2}$ inches.

It is needless to examine this any farther. We have collected enough for explaining the chief affections of the tides.

It is known that the earth is not a sphere, but swelled out at the equator by the diurnal rotation. But the change of form is so very small in proportion to the whole bulk, that it cannot sensibly affect the change of form afterwards induced by the sun on the waters of the ocean. For the disturbing force of the sun would produce a certain protuberance on a fluid sphere; and this protuberance depends on the ratio of the disturbing force to the force of gravity at the surface of this sphere. If the gravity be changed in any proportion, the protuberance will change in the same proportion. Therefore if the body be a spheroid, the protuberance produced at any point by the sun will increase or diminish in the same proportion that the gravity at this point has been changed by the change of form. Now the change of gravity, even at the pole of the terrestrial spheroid, is extremely small in comparison with the whole gravity. Therefore the change produced on the spheroid will not sensibly differ from that produced on the sphere; and the elevations of the waters above the surface, which they would have assumed independent of the sun's action, will be the same on the spheroid as on the sphere. For the same reason, the moon will change the surface already changed by the sun, in the same manner as she would have changed the surface of the undisturbed ocean. Therefore the change produced by both these luminaries in any place will be the same when acting together as when acting separately; and it will be equal to the sum, or the difference of their separate changes, according as these would have been in the same or in opposite directions.

Let us now consider the most interesting circumstances of the form of an elliptical tide, which differs very little from a sphere.

Let T (fig. 2.) be a point in the surface of the inscribed sphere, and let Z express the angular distance TOQ from the longer axis of the surrounding spheroid S *m* N *q*. Let TR, TW be perpendicular to the equatorial diameter and to the axis, so that they are the cosine and the sine of TOQ to the radius TO or QO. Let S′ *q* N′ be a section of the circumscribed sphere. Draw OT cutting the spheroid in Z and the circumscribed sphere in *t*. Also let *s o n* be a section of a sphere which has the same capacity with the spheroid, and let it cut the radius in *r*. Then, Fig. 2.

1. The elevation TZ of the point Z of the spheroid above the inscribed sphere is $= Q\,q \times \cos.^2 Z$, and the depression t Z below the circumscribed sphere is $= Q\,q \times \sin^2 Z$. Produce RT till it meet the surface of the spheroid in V. The minute triangle VTZ may be considered as rectilineal, right-angled at Z, and therefore similar to OTR. Therefore OT : TR = TV : TZ. But in the ellipse OQ, or OT : TR = Q q : TV. Therefore $OT^2 : TR^2 = Q\,q : TZ$, and $TZ = \frac{Q\,q \cdot TR^2}{OT^2}$,

$$= Q\,q : \frac{Q\,q \times \cos.^2 Z}{1}, = Q\,q \times \cos.^2 Z.$$

And in the very same manner it may be shown, that $t\,Z = Q\,q \times \sin.^2 Z$.

2. The elevation of the point T above another point T′, whose angular distance TOT′ from the point T is 90°, is $= Q\,q \times \overline{\cos.^2 Z - \sin.^2 Z}$. Call the angle QOT′ Z′. Then $\overline{T'\,Z' = Q\,q \times}\cos.^2 Z'$, and TZ—T′, Z′, $= Q\,q \times \cos.^2 Z - \cos.^2 Z'$. But the arch QT′ is the complement of QT, and therefore $\cos.^2 Z' = \sin.^2 Z$. Therefore $TZ - T', Z' = Q\,q \times \overline{\cos.^2 Z - \sin.^2 Z}$.

3. $Q\,o = \frac{1}{3}\,Q\,q$. For the inscribed sphere is to the spheroid as OQ to O q. But the inscribed sphere is to the sphere *s o n* as OQ^3 to $O\,o^3$. Therefore because the sphere *s o n* is equal to the spheroid S q N, we have $OQ : O\,q = OQ^3 : O\,o^3$, and O o is the first of two mean proportionals between OQ and O q. But Q q is very small in comparison with OQ. Therefore Q o is very nearly $\frac{1}{3}$ of Q q.

Since *s o n* is the sphere of equal capacity, it is the form of the undisturbed ocean. The best way therefore of conceiving the changes of form produced by the sun or moon, or by both together, is to consider the elevations or depressions which they produce above or below this surface. Therefore,

4. The

Tide.

4. The elevation r Z of the point Z above the equicapacious sphere is evidently $= \mathrm{Q}q \times \cos.^2 \mathrm{Z} - \frac{1}{3}\mathrm{Q}q$. Also the depression r' Z′ of the point Z′ is $= \mathrm{Q}q \times \sin.^2 \mathrm{Z}' - \frac{2}{3}\mathrm{Q}q$.

N. B. Either of these formulæ will answer for either the elevation above, or the depression below, the natural ocean: For if $\cos.^2\mathrm{Z}$ is less than $\frac{1}{3}$, the elevation given by the formula will be negative; that is, the point is below the natural surface. In like manner, when $\sin.^2\mathrm{Z}'$ is less than $\frac{2}{3}$, the depression is negative, and the point is above the surface. But if $\cos.^2\mathrm{Z}$ be $=\frac{1}{3}$, or $\sin.^2\mathrm{Z}'$ be $=\frac{2}{3}$, the point is in the natural surface. This marks the place where the spheroid and the equal sphere intersect each other, viz. in P′, the arch P′ o being $54^\circ\ 44'$ very nearly, and $\mathrm{PS}=35^\circ\ 16'$.

Let S represent the whole elevation of the pole of the solar tide above its equator, or the difference between high and low water produced by the sun: and let M represent the whole elevation produced by the moon. Let x and y represent the zenith distances of the sun and moon with respect to any point whatever on the ocean. Then x and y will be the arches intercepted between that point and the summits of the solar and lunar tides. Then the elevation produced by both luminaries in that plane is $\mathrm{S}\cdot\cos.^2 x - \frac{1}{3}\mathrm{S} + \mathrm{M}\cdot\cos.^2 y - \frac{1}{3}\mathrm{M}$; or, more concisely, $\mathrm{S}\cdot\cos.^2 x + \mathrm{M}\cdot\cos.^2 y - \frac{1}{3}\overline{\mathrm{S}+\mathrm{M}}$, and the depression is $\mathrm{S}\cdot\sin.^2 x + \mathrm{M}\cdot\sin.^2 y - \frac{2}{3}\overline{\mathrm{S}+\mathrm{M}}$.

Let the sun and moon be in the same point of the heavens. The solar and lunar tides will have the same axis; the cosines of x and y will each be 1, and the elevation at the compound pole will be $\mathrm{S}+\mathrm{M}-\frac{1}{3}\overline{\mathrm{S}+\mathrm{M}} = \frac{2}{3}\overline{\mathrm{S}+\mathrm{M}}$. The depression at any point 90° from this pole will be $\frac{1}{3}\overline{\mathrm{S}+\mathrm{M}}$, and the whole tide is S+M.

Let the moon be in quadrature, as in a (fig. 3.). The appearance at s will be known, by considering that in this place the cosine of x is 1, and the cosine of y is 0. Therefore the elevation at $s = \mathrm{S} - \frac{1}{3}\overline{\mathrm{S}+\mathrm{M}}, = \frac{2}{3}\mathrm{S} - \frac{1}{3}\mathrm{M}$.
The depression at $a = \mathrm{S} - \frac{2}{3}\overline{\mathrm{S}+\mathrm{M}} = \frac{1}{3}\mathrm{S} - \frac{2}{3}\mathrm{M}$.
The difference or whole tide $= \overline{\mathrm{S}-\mathrm{M}}$.
In like manner, the whole elevation at a above the inscribed sphere is M—S.

Hence we see that the whole tide, when the moon is in quadrature is the difference of S and M. We also see, that if M exceeds S, the water will be higher at a than at s. Now it is a matter of observation, that in the quadratures it is high water under the moon, and low water under the sun. It is also a matter of observation, that in the free ocean, the ebb tide, or the water at s, immediately under the sun, is below the natural surface of the ocean. Hence we must conclude, that $\frac{2}{3}$ S is less than $\frac{1}{3}$ M, or that M is more than double of S. This agrees with the phenomena of nutation and precession, which seem to make $\mathrm{S}=\frac{2}{5}$ of M.

In all other positions of the sun and moon, the place of high water will be different. It is high water where the sum of the elevations produced by both luminaries above the natural ocean is greatest; and the place of low water is where the depression below the natural ocean is greatest. Therefore, in order that it may be high water, we must have $\mathrm{S}\cdot\cos.^2 x + \mathrm{M}\cdot\cos.^2 y - \frac{1}{3}\overline{\mathrm{S}+\mathrm{M}}$ a maximum; or, neglecting the constant quantity $\frac{\mathrm{S}+\mathrm{M}}{3}$, we must have $\mathrm{S}\cdot\cos.^2 x + \mathrm{M}\cdot\cos.^2 y$ a maximum.

Tide.

In like manner, to have low water in a place where the zenith distance of the sun and moon are v and w, we must have $\mathrm{S}\cdot\sin.^2 v + \mathrm{M}\cdot\sin.^2 w$ a maximum.

Lemma 1. If we consider the sines and cosines of angles as numeral fractions of the radius 1, then we have $\cos.^2\mathrm{Z} = \frac{1}{2} + \frac{1}{2}\cos.^2\mathrm{Z}$, and $\sin.^2\mathrm{Z} = \frac{1}{2} - \frac{1}{2}\cos.^2\mathrm{Z}$.

Let $a\ m\ s$ (fig. 3.) be a quadrant of a circle of which O is the centre, and O s is the radius. On O s describe the semicircle OMS, cutting O m in M. Draw s M, and produce it till it cut the quadrant in n. Also draw MC to the centre of the semicircle, and MD and $n\ d$ perpendicular to O s. Fig. 3.

It is plain that s M is perpendicular to OM; and if O s be radius, s M is the sine of the angle s OM, which we may call Z; OM is its cosine: and because O s: OM = OM : OD, and O s : OD = O s^2 : OM², and OD may represent $\cos.^2$ Z. Now OD=OC+CD. If O s=1, then OC=$\frac{1}{2}$. CD=CM · cos. MCD, = CM · cos. 2 MOD, =$\frac{1}{2}$ · cos. 2 Z. Therefore, $\cos.^2\mathrm{Z} = \frac{1}{2} + \frac{1}{2}\cos.\ 2\mathrm{Z}$.

In like manner, because O s : s M = s M : s D, s D is = $\sin.^2$Z. This is evidently $= \frac{1}{2} - \frac{1}{2}\cos.\ 2\mathrm{Z}$.

Lemma 2. $\cos.^2\mathrm{Z} - \sin.^2\mathrm{Z} = \cos.\ 2\mathrm{Z}$. For, because s M is perpendicular to OM, the arch $s\ n$ is double of the arch $s\ m$, and because MD is parallel to $n\ d$, $s\ d$ is = 2 s D, and d D= $\sin.^2$Z. Therefore O d = $\cos.^2$Z —$\sin.^2$Z. But O d is the cosine of $n\ s$, =cos. 2Z and $\cos.^2\mathrm{Z} - \sin.^2\mathrm{Z} = \cos.\ 2\mathrm{Z}$.

By the first Lemma we see, that in order that there may be high water at any place, when the zenith distances of the sun and moon are x and y, we must have $\mathrm{S}\cdot\cos.\ 2x + \mathrm{M}\cdot\cos.\ 2y$ a maximum.

That this may be the case, the fluxion of this formula must be = 0. Now we know that the fluxions of the cosines of two arches are as the sines of those arches. Therefore we must have $\mathrm{S}\cdot\sin.\ 2x + \mathrm{M}\cdot\sin.\ 2y = 0$, or $\mathrm{S}\cdot\sin.\ 2x = -\mathrm{M}\cdot\sin.\ 2y$, which gives us $\sin.\ 2x : \sin.\ 2y = \mathrm{M} : \mathrm{S}$.

In like manner, the place of low water requires $\sin.\ 2v : \sin.\ 2w = \mathrm{M} : \mathrm{S}$.

From this last circumstance we learn, that the place of low water is 0, removed 90° from the place of high water; whereas we might have expected, that the spheroid would have been most protuberant on that side on which the moon is: For the sines of $2v$ and of $2w$ have the same proportion with the sines of $2x$ and of $2y$. Now we know that the sine of the double of any arch is the same with the sine of the double of its complement. Therefore if low water be really distant 90° from high water, we shall have $\sin.\ 2x : \sin.\ 2y = \sin.\ 2v : \sin.\ 2w$. But if it is at any other place, the sines cannot have this proportion.

Now let s be the point of the earth's surface which has the sun in the zenith, and m the point which has the moon in the zenith. Let h be any other point. Draw O h cutting the semicircle OM s in H. Make OM to CS as the disturbing force of the moon to that of the sun; and draw S v parallel, and S t, M r perpendicular to HH′. Join MH and MH′. The angle HC s is double of the angle HO s, and MCH is double of MH′H, or of its equal MOH. Because HMH is a semicircle, HM is perpendicular to MO. Therefore

fore if HH' be considered as radius, HM is the sine and $H'M$ is the cosine of $MH'H$. And Cr is $= MC \cdot \cos. 2y, = M \cdot \cos. 2y$. And Ct is $SC \cdot \cos. 2x$. Therefore tr or $S'v$ is $= S \cdot \cos. 2x + M \cdot \cos. 2y$. Therefore tr or Sv will express the whole difference of elevation between h and the points that are 90 degrees from it on either side (by *Lemma* 2.); and if h be the place of high water, it will express the whole tide, because the high and low waters were shown to be 90° asunder. But when h is the place of high water, Sv is a maximum. Because the place of the moon, and therefore the point M, is given, Sv will be a maximum when it coincides with SM, and CH is parallel to SM.

This suggested to us the following new, and not inelegant, solution of the problem for determining the place of high water.

Fig. 4. and 5. Let $sQoqs$ (fig. 4. and 5.) be a section of the terraqueous globe, by a plane passing through the sun and moon, and let O be its centre. Let s be the point which is immediately under the sun, and m the place immediately under the moon. Bisect Os in C, and describe round C the circle $OMsLO$, cutting Om in M. Take Cs to represent the disturbing force of the moon, and make Cs to CS as the force of the moon to that of the sun (supposing this ratio to be known). Join MS, and draw CH parallel to it. Draw OHh, and $lOLl'$ perpendicular to it. And lastly, draw CI perpendicular to SM. Then we say that m and its opposite m' are the places of high water, l and l' are the places of low water, MS is the height of the tide, and MI, SI are the portions of this tide produced by the moon and sun.

For it is plain, that in this case the line Sv of the last proposition coincides with MS, and is a maximum. We may also observe, that $MC : CS = \sin. MSC : \sin. SMC, = \sin. HCS : \sin. MCH, = \sin\ 2hOs : \sin. 2hOm, = \sin. 2x : \sin. 2y$, or $M : S = \sin. 2x : \sin. 2y$, agreeably to what was required for the maximum.

It is also evident, that $MI = MC \cdot \cos. CMI, = M \cdot \cos. 2y$, and $SI = SC \cdot \cos. ISC, = S \cdot \cos. 2x$; and therefore MS is the difference of elevation between h and the points l and l', which are 90° from it, and is therefore the place of low water; that is, MS is the whole tide.

The elevation of every other point may be determined in the same way, and thus may the form of the spheroid be completely determined.

If we suppose the figure to represent a section through the earth's equator (which is the case when the sun and moon are in the equator), and farther suppose the two luminaries to be in conjunction, the ocean is an oblong spheroid, whose axis is in the line of the syzigies, and whose equator coincides with the six hour circle. But if the moon be in any other point of the equator, the figure of the ocean will be very complicated. It will not be any figure of revolution; because neither its equator (or most depressed part) nor its meridians are circles. The most depressed part of its equator will be in that section through the axis which is perpendicular to the plane in which the luminaries are situated. And this greatest depression, and its shortest equatorial diameter will be constant, while its other dimensions vary with the moon's place. We need not inquire more minutely into its form; and it is sufficient to know that all the sections perpendicular to the plane passing through the sun and moon are ellipses.

This construction will afford us a very simple, and, we hope, a very perspicuous explanation of the chief phenomena of the tides. The well informed reader will be pleased with observing its coincidence with the algebraic solution of the problem given by Daniel Bernoulli, in his excellent dissertation on the Tides, which shared with M'Laurin and Euler the prize given by the Academy of Sciences at Paris, and with the ease and perspicuity with which the phenomena are deducible from it, being in some sort exhibited to the eye.

In our application, we shall begin with the simplest cases, and gradually introduce the complicating circumstances which accommodate the theory to the true state of things.

We begin, therefore, by supposing the earth covered, to a proper depth, with water, forming an ocean concentric with its solid nucleus.

In the next place, we suppose that this ocean adopts in an instant the form which is consistent with the equilibrium of gravity and the disturbing forces.

Thirdly, We suppose the sun stationary, and the moon to move eastward from him above $12\frac{1}{5}$° every day.

Fourthly, We suppose that the solid nucleus turns round its proper axis to the eastward, making a rotation in 24 solar hours. Thus any place of observation will successively experience all the different depths of water.

Thus we shall obtain a certain SUCCESSION of phenomena, precisely similar to the succession observed in nature, with this sole difference, that they do not correspond to the contemporaneous situations of the sun and moon. When we shall have accounted for this difference, we shall presume to think that we have given a just theory of the tides.

We begin with the simplest case, supposing the sun and moon to be always in the equator. Let the series begin with the sun and moon in conjunction in the line Os. In this case the points s, m, and h coincide, and we have high water at 12 o'clock noon and midnight.

While the moon moves from s to Q, Om cuts the upper semicircle in M; and therefore CH, which is always parallel to MS, lies between MC and Cs. Therefore h is between m and s, and we have high water after 12 o'clock, but before the moon's southing. The same thing happens while the moon moves from o to q, during her third quarter.

But while the moon moves from her first quadrature in Q to opposition in o (as in fig, 5.), the line mO drawn from the moon's place, cuts the lower semicircle in M, and CH, parallel to SM, again lies between M and s, and therefore h lies between m and o. The place of high water is to the eastward of the moon, and we have high water after the moon's southing. The same thing happens while the moon is moving from her last quadrature in q to the next syzigy. In short, the point H is always between M and s, and the place of high water is always between the moon and the *nearest* syzigy. The place of high water overtakes the moon in each quadrature, and is overtaken by the moon in each syzigy. Therefore during the first and third quarters, the place of high water gradually falls behind the moon for some time, and then gains upon her again, so

as

as to overtake her in the next quadrature. But during the second and fourth quarters, the place of high water advances before the moon to a certain distance, and then the moon gains upon it, and overtakes it in the next syzigy.

If therefore we suppose the moon to advance uniformly along the equator, the place of high water moves unequally, slowest in the time of new and full moon, and swiftest in the time of the quadratures. There must be some intermediate situations where the place of high water neither gains nor loses upon the moon, but moves with the same velocity.

The rate of motion of the point h may be determined as follows: Draw C i, S n, making very small and equal angles with HC and MS. Draw n C, and about S, with the distance S n, describe the arch $n\,v$, which may be considered as a straight line perpendicular to n S, or to MS.

Then, because SM and S n are parallel to CH and Ci, the points n and i are contemporaneous situations of M and H, and the arches n M, i H, are in the ratio of the angular motions of m and h. Also, because $n\,v$ and n M are perpendicular to n S and n C, the angle $v\,n$ M is equal to the angle SnC, or SMC. Also, because the angles $n\,v$ M and MIC are right angles, and the angles $v\,n$ M, CMI, are also equal, the triangles $v\,n$ M, CMI, are similar. Therefore

nM : $n\,v$=MC : MI. And

$n\,v$: iH=nS : iC, or = MS : MC; therefore

nM : iH=MS : MI. Therefore the angular motion of the moon is to the angular motion of the place of high water as MS to MI.

Therefore, when M'S is perpendicular to SC, and the point I coincides with S, the motion of high water is equal to that of the moon. But when M'S is perpendicular to SC, H'C is also perpendicular to C s, and the angle h' O s is 45°, and the high water is in the octant. While the moon passes from s to m', or the high water from s to h', the point I falls between M and S, and the motion of high water is slower than that of the moon. The contrary obtains while the moon moves from m' to Q, or the high water from the octant to the quadrature.

It is evident, that the motion of h in the third quarter of the lunation, that is, in passing from o to q, is similar to its motion from s to Q. Also, that its motion from Q to o must retard by the same degrees as it accelerated in passing from s to Q, and that its motion in the last quarter from q to s is similar to its motion from Q to o.

At new and full moon the point I coincides with C, and the point M coincides with s. Therefore the motion of the high water at full and change is to the motion of the moon as s C to s S. But when the moon is in quadrature, I coincides with C, and M with o. Therefore the motion of the moon is to that of high water as OS to OC or s C. Therefore the motion of high water at full and change is to its motion in the quadratures as OS to S s, or as the difference of the disturbing forces to their sum. The motion of the tide is therefore slowest in the syzigies and swiftest in the quadratures; yet even in the syzigies it passes the sun along with the moon, but more slowly.

Let the interval between the morning tide of one day and that of the next day be called a *tide-day*. This is always greater than a solar day, or 24h 0m, because the place of high water is moving faster to the eastward than the sun. It is less than a lunar day, or 24h. 50', while the high water passes from the second to the third octant, or from the fourth to the first. It is equal to a lunar day when high water is in the octants, and it exceeds a lunar day while high water passes from the first to the second octant, or from the third to the fourth.

The difference between a solar day and a tide day is called the PRIMING or the RETARDATION of the tides. This is evidently equal to the time of the earth's describing in its rotation an angle equal to the motion of the high water in a day from the sun. The smallest of these retardations is to the greatest as the difference of the disturbing forces to their sum. Of all the phenomena of the tides, this seems liable to the fewest and most inconsiderable derangements from local and accidental circumstances. It therefore affords the best means for determining the proportion of the disturbing forces. By a comparison of a great number of observations made by Dr Maskelyne at St Helena, and at Barbadoes (places situated in the open sea), it appears that the shortest tide-day is 24h. 37', and the longest is 25h. 27'. This gives M—S : M+S=37 : 87, and S : M =2 : 4.96; which differs only 1 part in 124 from the proportion of 2 to 5, which Daniel Bernoulli collected from a variety of different observations. We shall therefore adopt the proportion of 2 to 5 as abundantly exact. It also agrees exactly with the phenomena of the nutation of the earth's axis and the precession of the equinoxes; and the astronomers affect to have deduced this proportion from these phenomena. But an intelligent reader of their writings will perceive more finesse than justice in this assertion. The nutation and precession *do not* afford phenomena of which we can assign the share to each luminary with sufficient precision for determining the proportion of their disturbing forces; and it is by means of many arbitrary combinations, and without necessity, that D'Alembert has made out this ratio. We cannot help being of opinion, that D'Alembert has accommodated his distribution of the phenomena to this ratio of 2 to 5, which Daniel Bernoulli (the best philosopher and the most candid man of that illustrious family of mathematicians) had, with so much sagacity and justness of inference, deduced from the phenomena of the tides. D'Alembert could not but see the value of this inference; but he wanted to show his own address in deducing it *proprio marte* forsooth from the nutation and precession. His procedure in this resembles that of his no less vain countryman De la Place, who affects to be highly pleased with finding that Mr Bode's discovery that Meyer had seen the Georgium Sidus in 1756, perfectly agreed with the theory of its motions which he (De la Place) had deduced from his own doctrines. Any well informed mathematician will see, that De la Place's data afforded no such precision; and the Book on the Elliptical Motions of the Planets, to which he alludes, contains no grounds for his inference. This observation we owe to the author of a paper on that subject in the Transactions of the Royal Society of Edinburgh. We hope that our readers will excuse this occasional observation, by which we wish to do justice to the merit of a modest man, and one of the greatest philosophers of his time. Our only claim in the present dissertation is the making his excellent performance

Tide. formance on the tides accessible to an Enlish reader not much versant in mathematical researches; and we are sorry that our limits do not admit any thing more than a sketch of it. But to proceed.

Assuming 2 : 5 as the ratio of SC to CM′, we have the angle CM′S=23° 34′ nearly, and $m'oh'$=11°47′; and this is the greatest difference between the moon's place and the place of high water. And when this obtains, the moon's elongation $m'os$ is 56° 47′ from the nearest syzigy. Hence it follows, that while the moon moves uniformly from 56° 47′ west elongation to 56° 47′ east, or from 123° 13′ east to 123° 13′ west, the tide day is shorter than the lunar day; and while she moves from 56° 47′ east to 123° 13′, or from 123° 13′ west to 56° 47′, the tide day is longer than the lunar day.

We see now the reason why

———The swelling tides obey the moon.

The time of high water, when the sun and moon are in the equator, is never more than 47 minutes different from that of the moon's southing (+ or — a certain fixed quantity, to be determined once for all by observation).

It is now an easy matter to determine the hour of high water corresponding to any position of the sun and moon in the equator. Suppose that on the noon of a certain day the moon's distance from the sun is ms. The construction of this problem gives us sh, and the length of the tide day. Call this T. Then say 360° : sm=T : t, and t is the hour of high water.

Or, if we choose to refer the time of high water to the moon's southing, we must find the value of mh at the time of the moon's southing, and the difference d between the tide day and the mean lunar day L, and say 360 : mh=d : ☽, the time of high water before the moon's southing in the first and third quarters, but after it in the second and fourth. The following table by Daniel Bernoulli exhibits these times for every 10th degree of the moon's elongation from the sun. The first or leading column is the moon's elongation from the sun or from the point of opposition. The second column is the minutes of time between the moon's southing and the place of high water. The marks — and + distinguish whether the high water is before or after the moon's southing. The third column is the hour and minute of high water. But we must remark that the first column exhibits the elongation, not on the noon of any day, but at the very time of high water. The two remaining columns express the heights of the tides and their daily variations.

$ms.$	mh	$sh.$	M.S.	Mv.
°	′	h. ′		
0	0	0. 0	1000	
	—			
10	11½	0.28½	987	13
20	22 —	0.58	949	38
30	31½—	1.28½	887	62
40	40 —	2.—	806	81
50	45 —	2.35	715	91
60	46½—	3.13½	610	105
70	40½—	3.59½	518	92
80	25 —	4.55	453	65
				24
90	0	6.—	429	—
	+			
100	25 +	7. 5	453	24
110	40½+	8. 0½	518	65
120	46½+	8.46½	610	92
130	45 +	9.25	715	105
140	40 +	10.—	806	91
150	31½+	10.31½	887	81
160	22 +	11. 2	949	62
170	11½+	11.31½	987	38
180	0	12.—	1000	13

The height of high water above the low water constitutes what is usually called the tide. This is the interesting circumstance in practice. Many circumstances render it almost impossible to say what is the elevation of high water above the natural surface of the ocean. In many places the surface at low water is above the natural surface of the ocean. This is the case in rivers at a great distance from their mouths. This may appear absurd, and is certainly very paradoxical; but it is a fact established on the most unexceptionable authority. One instance fell under our own observation. The low-water-mark at spring tide in the harbour of Alloa was found by accurate levelling to be three feet higher than the top of the stone pier at Leith, which is several feet above the high water mark of this harbour. A little attention to the motion of running waters will explain this completely. Whatever checks the motion of water in a canal must raise its surface. Water in a canal runs only in consequence of the declivity of this surface: (See RIVER). Therefore a flood tide coming to the mouth of a river checks the current of its waters, and they accumulate at the mouth. This checks the current farther up, and therefore the waters accumulate there also; and this checking of the stream, and consequent rising of the waters, is gradually communicated up the river to a great distance. The water rises everywhere, though its surface still has a slope. In the mean time, the flood tide at the mouth passes by, and an ebb succeeds. This must accelerate even the ordinary course of the river. It will more remarkably accelerate the river now raised above its ordinary level, because the declivity at the mouth will be so much greater. Therefore the waters near the mouth, by accelerating, will sink in their channel, and increase the declivity of the canal beyond them. This will accelerate the waters beyond them; and thus a stream more rapid than ordinary will be produced along the whole river,

river, and the waters will sink below their ordinary level. Thus there will be an ebb below the ordinary surface as well as a flood above it, however sloping that surface may be.

Hence it follows, that we cannot tell what is the natural surface of the ocean by any observations made in a river, even though near its mouth. Yet even in rivers we have regular tides, subjected to all the varieties deduced from this theory.

We have seen that the tide is always proportional to MS. It is greatest therefore when the moon is in conjunction or opposition, being then S s, the sum of the separate tides produced by the sun and moon. It gradually decreases as the moon approaches to quadrature; and when she is at Q or q, it is SO, or the difference of the separate tides. Supposing S s divided into 1000 equal parts, the length of MS is expressed in these parts in the fourth column of the foregoing table, and their differences are expressed in the fifth column.

We may here observe, that the variations of the tides in equal small times are proportional to the sine of twice the distance of the place of high water from the moon. For since M n is a constant quantity, on the supposition of the moon's uniform motion, M v is proportional to the variation of MS. Now M n : M v=MC : CI=1 : sin. $2y$, and M n and MC are constant quantities.

Thus we have seen with what ease the geometrical construction of this problem not only explains all the interesting circumstances of the tides, but also points them out, almost without employing the judgment, and exhibits to the eye the gradual progress of each phenomenon. In these respects it has great advantages over the very elegant algebraic analysis of Mr Bernoulli. In that process we advance almost without ideas, and obtain our solutions as detached facts, without perceiving their regular series. This is the usual pre-eminence of geometrical analysis; and we regret that Mr Bernoulli, who was eminent in this branch, did not rather employ it. We doubt not but that he would have shown still more clearly the connection and gradual progress of every particular. His aim, however, being to instruct those who were to calculate tables of the different affections of the tides, he adhered to the algebraic method. Unfortunately it did not present him with the easiest formulæ for practice. But the geometrical construction which we have given suggests several formulæ which are exceedingly simple, and afford a very ready mode of calculation.

The fundamental problems are to determine the angle s O h or m O h, having m O s given; and to determine MS.

Let the given angle m O s be called a; and, to avoid the ambiguity of algebraic signs, let it always be reckoned from the nearest syzigy, so that we may always have a equal to the sum of x and y. Also make $d^2=\frac{S^2\times\sin.^2 2a}{M^2+S^2+2M\times S\times\cos. 2a}$, which represents the $\frac{Sc^2}{SM^2}$ of fig. 4. or sin.^{2} $2y$, and make $p=\frac{S\times\sin. 2a}{M+S\times\cos. 2a}$, which is the expression of $\frac{Sc}{Mc}$ of that figure, or of tan. $2y$. Then we shall have,

1. Sin. $y=\sqrt{\frac{1-\sqrt{1-d^2}}{2}}$. For we shall have cos. $2y=\sqrt{1-d^2}$. But sin.$^2 y=\frac{1}{2}-\frac{1}{2}\cos. 2y=1-\frac{\sqrt{1-d^2}}{2}$, and sin. $y=\sqrt{\frac{1-\sqrt{1-d^2}}{2}}$.

2. Tan. $y=\frac{p}{1+\sqrt{1+p^2}}$. For because p is = tan. $2y$, $\sqrt{1+p^2}$ is the secant of $2y$, and $1+\sqrt{1+p^2}:1=p:\tan. y$.

These processes for obtaining y directly are abundantly simple. But it will be much more expeditious and easy to content ourselves with obtaining $2y$ by means of the value of its tangent, viz. $\frac{S\cdot\sin. 2a}{M+S\cdot\cos. 2a}$. Or, we may find x by means of the similar value of its tangent $\frac{Md}{Sd}$ of fig. 4.

There is still an easier method of finding both $2x$ and $2y$, as follows.

Make M+S : M—S=tan. a : tan. b. Then b is the difference of x and y, as a is their sum. For this analogy evidently gives the tangent of half the difference of the angles CSM and CMS of fig. 4. or of $2x$ and $2y$. Therefore to a, which is half the sum of $2x+2y$, add b, and we have $2x=a+b$, or $x=\frac{a+b}{2}$, and $y=\frac{a-b}{2}$.

By either of these methods a table may be readily computed of the value of x or y for every value of a.

But we must recollect that the values of S and M are by no means constant, but vary in the inverse triplicate ratio of the earth's distance from the sun and moon; and the ratio of 2 to 5 obtains only when these luminaries are at their mean distances from the earth. The forces corresponding to the perigean, medium, and apogean distances are as follow.

		Sun.	Moon.
Apogean	-	1.901	4.258
Medium	-	2.	5.
Perigean	-	2.105	5.925

Hence we see that the ratio of S to M may vary from 1.901 : 5.925 to 2.105 : 4.258, that is, nearly from 1 : 3 to 1 : 2, or from 2 : 6 to 2 : 4. The solar force does not vary much, and may be retained as constant without any great error. But the change of the moon's force has great effects on the tides both as to their time and their quantity.

I. In respect of their Time.

1. The tide day following a spring tide is 24 h. 27′ when the moon is in perigee, but 24 h. 33′ when she is in apogee.

2. The tide day following neap tide is 25 h. 15′, and 25 h. 40′ in these two situations of the moon.

3. The greatest interval of time between high water and the moon's southing is 39′ and 61′; the angle

y

y being $9^\circ 45'$ in the first case, and $15^\circ 15'$ in the second.

II. In respect of their Heights.

1. If the moon is in perigee when new or full, the spring tide will be 8 feet instead of 7, which corresponds to her mean distance. The very next spring tide happens when she is near her apogee, and will be 6 feet instead of 7. The neap tides happen when she is at her mean distance, and will therefore be 3 feet.

But if the moon be at her mean distance when new or full, the two succeeding spring tides will be regular or 7 feet, and one of the neap tides will be 4 feet and the other only 2 feet.

Mr Bernoulli has given us the following table of the time of high water for these three chief situations of the moon, namely, her perigee, mean distance, and apogee. It may be had by interpolation for all intermediate positions with as great accuracy as can be hoped for in phenomena which are subject to such a complication of disturbances. The first column contains the moon's elongation from the sun. The columns P, M, A, contain the minutes of time which elapse between the moon's southing and high water, according as she is in perigee, at her mean distance, or in apogee. The sign — indicates the priority, and + the posteriority, of high water to the moon's southing.

☽ and ☉	P.	M.	A.
0	0	0	0
	—	—	—
10	$9\frac{1}{2}$	$11\frac{1}{2}$	14
20	18	22	$27\frac{1}{2}$
30	26	$31\frac{1}{2}$	$39\frac{1}{2}$
40	33	40	50
50	$37\frac{1}{2}$	45	56
60	$38\frac{1}{2}$	$46\frac{1}{2}$	58
70	$33\frac{1}{2}$	$40\frac{1}{2}$	$50\frac{1}{2}$
80	22	25	31
90	0	0	0
	+	+	+
100	21	25	31
110	$33\frac{1}{2}$	$40\frac{1}{2}$	$50\frac{1}{2}$
120	$38\frac{1}{2}$	$46\frac{1}{2}$	58
130	$37\frac{1}{2}$	45	56
140	33	40	50
150	26	$31\frac{1}{2}$	$39\frac{1}{2}$
160	18	22	$27\frac{1}{2}$
170	$9\frac{1}{2}$	$11\frac{1}{2}$	14
180	0	0	0

The reader will undoubtedly be making some comparison in his own mind of the deductions from this theory with the actual state of things. He will find some considerable resemblances; but he will also find such great differences as will make him very doubtful of its justness. In very few places does the high water happen within three-fourths of an hour of the moon's southing, as the theory leads him to expect; and in no place whatever does the spring tide fall on the day of new and full moon, nor the neap tide on the day of her quadrature. These always happen two or three days later. By comparing the difference of high water and the moon's southing in different places, he will hardly find any connecting principle. This shows evidently that the cause of this irregularity is local, and that the justness of the theory is not affected by it. By considering the phenomena in a navigable river, he will learn the real cause of the deviation. A flood tide arrives at the mouth of a river. The true theoretical tide differs in no respect from a wave. Suppose a spring tide actually formed on a fluid sphere, and the sun and moon then annihilated. The elevation must sink, pressing the under waters aside, and causing them to rise where they were depressed. The motion will not stop when the surface comes to a level; for the waters arrived at that position with a motion continually accelerated. They will therefore pass this position as a pendulum passes the perpendicular, and will rise as far on the other side, forming a high water where it was low water, and a low water where it was high water; and this would go on for ever, oscillating in a time which mathematicians can determine, if it were not for the viscidity, or something like friction, of the waters. If the sphere is not fluid to the centre, the motion of this wave will be different. The elevated waters cannot sink without diffusing themselves sidewise, and occasioning a great horizontal motion, in order to fill up the hollow at the place of low water. This motion will be greatest about half way between the places of high and low water. The shallower we suppose the ocean, the greater must this horizontal motion be. The resistance of the bottom (though perfectly smooth and even) will greatly retard it all the way to the surface. Still, however, it will move till all be level, and will even move a little farther, and produce a small flood and ebb where the ebb and flood had been. Then a contrary motion will obtain; and after a few oscillations, which can be calculated, it will be insensible. If the bottom of the ocean (which we still suppose to cover the whole earth) be uneven, with long extended valleys running in various directions, and with elevations reaching near the surface, it is evident that this must occasion great irregularities in the motion of the undermost waters, both in respect of velocity and direction, and even occasion small inequalities on the surface, as we see in a river with a rugged bottom and rapid current. The deviations of the under currents will drag with them the contiguous incumbent waters, and thus occasion greater superficial irregularities.

Now a flood arriving at the mouth of a river, must act precisely as this great wave does. It must be propagated up the river (or along it, even though perfectly level) in a certain time, and we shall have high water at all the different places in succession. This is distinctly seen in all rivers. It is high water at the mouth of the Thames at three o'clock, and later as we go up the river, till at London bridge we have not high water till three o'clock in the morning, at which time it is again high water at the Nore. But, in the mean time, there has been low water at the Nore, and high water about half way to London; and while the high water is proceeding to London, it is ebbing at this intermediate place, and is low water there when it is high water at London and at the Nore. Did the tide extend as far beyond London as London is from the Nore, we should

Tide. should have three high waters with two low waters interposed. The most remarkable instance of this kind is the Maragnon or Amazon river in South America. It appears by the observations of Condamine and others, that between Para, at the mouth of the river, and the conflux of the Madera and Maragnon, there are seven coexistent high waters, with six low waters between them. Nothing can more evidently show that the tides in these places are nothing but the propagation of a wave. The velocity of its superficial motion, and the distance to which it will sensibly go, must depend on many circumstances. A deep channel and gentle acclivity will allow it to proceed much farther up the river, and the distance between the successive summits will be greater than when the channel is shallow and steep. If we apply the ingenious theory of Chevalier Buat delivered in the article River, we may tell both the velocity of the motion and the interval of the successive high waters. It may be imitated in artificial canals, and experiments of this kind would be very instructive. We have said enough at present for our purpose of explaining the irregularity of the times of high water in different places, with respect to the moon's southing. For we now see clearly that something of the same kind must happen in all great arms of the sea which are of an oblong shape, and communicate by one end with the open ocean. The general tide in this ocean must proceed along this channel, and the high water will happen on its shores in succession. This also is distinctly seen. The tide in the Atlantic ocean produces high water at new and full moon at a later and later hour along the south coast of Great Britain in proportion as we proceed from Scilly islands to Dover. In the same manner it is later and later as we come along the east coast from Orkney to Dover. Yet even in this progress there are considerable irregularities, owing to the sinuosities of the shores, deep indented bays, prominent capes, and extensive ridges and valleys in the channel. A similar progress is observed along the coasts of Spain and France, the tide advancing gradually from the south, turning round Cape Finisterre, ranging along the north coast of Spain, and along the west and north coasts of France.

The attentive consideration of these facts will not only satisfy us with respect to this difficulty, but will enable us to trace a principle of connection amidst all the irregularities that we observe.

We now add, that if we note the difference between the time of high water of spring tide, as given by theory, for any place, and the *observed time* of high water, we shall find this interval to be very nearly constant through the whole series of tides during a lunation. Suppose this interval to be 40 hours. We shall find every other phenomenon succeed after the same interval. And if we suppose the moon to be in the place where she was 40 hours before, the observation will agree pretty well with the theory, as to the succession of tides, the length of tide day, the retardations of the tides, and their gradual diminution from spring to neap tide. We say pretty well; for there still remain several small irregularities, different in different places, and not following any observable law. These are therefore local, and owing to local causes. Some of these we shall afterwards point out. There is also a general deviation of the theory from the real series of tides. The neap tides, and those adjoining, happen a little earlier than the corrected theory points out. Thus at Brest (where more numerous and accurate observations have been made than at any other place in Europe), when the moon changes precisely at noon, it is high water at 3 h 28′. When the moon enters her second quarter at noon, it is high water at 8 h. 40′, instead of 9 h. 48′, which theory assigns.

Something similar, and within a very few minutes equal, to this is observed in *every* place on the sea-coast. This is therefore something general, and indicates a real defect in the theory.

But this arises from the same cause with the other general deviation, viz. that the greatest and least tides do not happen on the days of full and half moon, but a certain time after. We shall attempt to explain this.

We set out with the supposition, that the water acquired in an instant the elevation competent to its equilibrium. But this is not true. No motion is instantaneous, however great the force; and every motion and change of motion produced by a sensible or finite force increases from nothing to a sensible quantity by infinitely small degrees. Time elapses before the body can acquire any sensible velocity; and in order to acquire the same sensible velocity by the action of different forces acting similarly, a time must elapse inversely proportional to the force. An infinitely small force requires a finite time for communicating even an infinitely small velocity; and a finite force, in an infinitely small time, communicates only an infinitely small velocity; and if there be any kind of motion which changes by insensible degrees, it requires a finite force to prevent this change. Thus a bucket of water, hanging by a cord lapped round a light and easily moveable cylinder, will run down with a motion uniformly accelerated; but this motion will be prevented by hanging an equal bucket on the other side, so as to act with a finite force. This force prevents only infinitely small accelerations.

Now let ALKF (fig. 6.) be the solid nucleus of the earth, surrounded by the spherical ocean $bhdg$. Let this be raised to a spheroid BHDG by the action of the moon at M, or in the direction of the axis CM. If all be at rest, this spheroid may have the form precisely competent to its equilibrium. But let the nucleus, with its spheroidal ocean, have a motion round C in the direction AFKL from west to east. When the line of water BA is carried into the situation sq infinitely near to BA, it is no longer in equilibrio; for s is too elevated, and the part now come to B is too much depressed. There is a force tending to depress the waters at s, and to raise those now at B; but this force is infinitely small. It cannot therefore restore the shape competent to equilibrium till a sensible time has elapsed; therefore the disturbing force of the moon cannot keep the summit of the ocean in the line MC. The force must be of a certain determinate magnitude before it can in an instant undo the instantaneous effect of the rotation of the waters and keep the summit of the ocean in the same place. But this effect is possible; for the depression at s necessary for this purpose is nearly as the distance from B, being a depression, not from a straight line, but from a circle described with the radius CB. It is therefore an infinitesimal of the first order, and may be restored in an instant, or the continuation of the depression Fig. 6.

pression prevented by a certain finite force. Therefore there is some distance, such as By, where the disturbing force of the moon may have the necessary intensity. Therefore the spherical ocean, instead of being kept continually accumulated at B and D, as the waters turn round, will be kept accumulated at y and y', but at a height somewhat smaller. It is much in this way that we keep melted pitch or other clammy matter from running off from a brush, by continually turning it round, and it hangs protuberant, not from the lowest point, but from a point beyond it, in the direction of its motion. The facts are very similar. The following experiment will illustrate this completely, and is quite a parallel fact. Conceive GDH, the lower half of the ellipse, to be a supple heavy rope or chain hanging from a roller with a handle. The weight of the rope makes it hang in an oblong curve, just as the force of the moon raises the waters of the ocean. Turn the roller very slowly, and the rope, unwinding at one side and winding up on the other side of the roller, will continue to form the same curve: but turn the roller very briskly in the direction FKL, and the rope will now hang like the curve $u\,y'\,v$, considerably advanced from the perpendicular, so far, to wit, that the force of gravity may be able in an instant to undo the infinitely small elevation produced by the turning.

We are very anxious to have this circumstance clearly conceived, and its truth firmly established; because we have observed it to puzzle many persons not unaccustomed to such discussions: we therefore hope that our readers, who have got over the difficulty, will indulge us while we give yet another view of this matter, which leads us to the same conclusion.

It is certain that the interval between high and low water is not sufficient for producing all the accumulation necessary for equilibrium in an ocean so very shallow. The horizontal motion necessary for gathering together so much water along a shallow sea would be prodigious. Therefore it never attains its full height; and when the waters, already raised to a certain degree, have passed the situation immediately under the moon, they are still under the action of accumulating forces, although these forces are now diminished. They will continue rising, till they have so far past the moon, that their situation subjects them to depressing forces. If they have acquired this situation with an accelerated motion, they will rise still farther by their inherent motion, till the depressing forces have destroyed all their acceleration, and then they will begin to sink again. It is in this way that the nutation of the earth's axis produces the greatest inclination, not when the inclining forces are greatest, but three months after. It is thus that the warmest time of the day is a considerable while after noon, and that the warmest season is considerably after midsummer. The warmth increases till the momentary waste of heat exceeds the momentary supply. We conclude by saying, that it may be demonstrated, that, in a sphere fluid to the centre, the time of high water cannot be less, and may be more, than three lunar hours after the moon's southing. As the depth of the ocean diminishes, this interval also diminishes.

It is perhaps impossible to assign the distance By at which the summit of the ocean may be kept while the earth turns round its axis. We can only see, that it must be less when the accumulating force is greater, and therefore less in spring tides than in neap tides; but the difference may be insensible. All this depends on circumstances which we are little acquainted with; many of these circumstances are local; and the situation of the summit of the ocean, with respect to the moon, may be different in different places.

Nor have we been able to determine theoretically what will be the height of the summit. It will certainly be less than the height necessary for perfect equilibrium. Daniel Bernoulli says, that, after very attentive consideration, he is convinced that the height at new or full moon will be to the theoretical height as the cosine of the angle BCy to radius, or that the height at y will be $\mathrm{B}b \times \frac{\mathrm{C}n}{\mathrm{C}b}$.

The result of all this reasoning is, that we must always suppose the summit of the tide is at a certain distance eastward from the place assigned by the theory. Mr Bernoulli concludes, from a very copious comparison of observations at different places, that the place of high water is about 20 degrees to the eastward of the place assigned by the theory. Therefore the table formerly given will correspond with observation, if the leading column of the moon's elongation from the sun be altered accordingly. We have inserted it again in this place, with this alteration, and added three columns for the times of high water. Thus changed it will be of great use.

We have now an explanation of the acceleration of the neap tides, which should happen 6 hours later than the spring tides. They are in fact tides corresponding to positions of the moon, which are 20° more, and not the real spring and neap tides. These do not happen till two days after; and if the really greatest and least tides be observed, the least will be found 6 hours later than the first.

Elong. of Moon.	High Water before or after Moon's Southing.			Time of High Water.		
	Perigee.	M. Dist.	Apogee.	Perigee.	M. Dist.	Apogee.
0	18 after	22 after	27½ after	0.18	0.22	0.27½
10	9½ do.	11½	14	0.49½	0.51½	0.54
20	0 do.	0	0	1.20	1.20	1.20
30	9½ bef.	11½ bef.	14 bef.	1.50½	1.48	1.46
40	18 do.	22	27½	2.22	2.18	2.12
50	26	31½	39½	2.54	2.48	2.40
60	33	40	50	3.27	3.20	3.10
70	37½	45	56	4.02½	3.55	3.44
80	38½	46½	58	4.41½	4.33	4.22
90	33½	40½	50½	5.26½	5.19	5.09
100	22	25	31	6.19	6.15	6.09
110	0	0	0	7.20	7.20	7.20
120	22 after	25 after	31 after	8.21	8.25	8.31
130	33½ after	40½	50½	9.13½	9.20	9.30
140	38½	46½	58	9.58½	10.06	10.18
150	37½	45	56	10.37½	10.45	10.56
160	33	40	50	11.13	11.20	11.30
170	26	31½	29½	11.46	11.51	11.59
180	18	22	27½	0.18	0.22	0.27

This table is general, and exhibits the time of high water, Tide. water, and their difference from those of the moon's southing, in the open sea, from all local obstructions. If therefore the time of high water in any place on the earth's equator (for we have hitherto considered no other) be different from this table (supposed correct), we must attribute the difference to the distinguishing circumstances of the situation. Thus every place on the equator should have high water on the day that the moon, situated at her mean distance, changes precisely at noon, at 22 minutes past noon; because the moon passes the meridian along with the sun by supposition. Therefore, to make use of this table, we must take the difference between the first number of the column, intitled time of high water, from the time of high water at full and change peculiar to any place, and add this to all the numbers of that column. This adapts the table to the given place. Thus, to know the time of high water at Leith, when the moon is 50° east of the sun, at her mean distance from the earth, take 22′ from 4h. 30′, there remains 4.08. Add this to 2h. 48′ and we have 6° 56′ for the hour of high water. The hour of high water at new and full moon for Edinburgh is marked 4h. 30′ in Maskelyne's tables, but we do not pretend to give it as the exact determination. This would require a series of accurate observations.

It is by no means an easy matter to ascertain the time of high water with precision. It changes so very slowly, that we may easily mistake the exact minute. The best method is to have a pipe with a small hole near its bottom, and a float with a long graduated rod. The water gets in by the small hole, and raises the float, and the smallness of the hole prevents the sudden and irregular starts which waves would occasion. Instead of observing the moment of high water, observe the height of the rod about half an hour before, and wait after high water till the rod comes again to that height. Take the middle between them. The water rises sensibly half an hour before the top of the tide, and quickly changes the height of the rod, so that we cannot make a great mistake in the time.

Mr Bernoulli has made a very careful comparison of the theory thus corrected, with the great collection of observations preserved in the *Depot de la Marine* at Brest and Rochfort *; and finds the coincidence very great, and far exceeding any rule which we had ever seen. Indeed we have no rules but what are purely empirical, or which suppose a uniform progression of the tides.

* See Mr Cassini, *Mem. Acad. Par.* 1734.

The heights of the tides are much more affected by local circumstances than the regular series of their times. The regular spring tide should be to the neap tide in the same proportion in all places; but nothing is more different than this proportion. In some places the spring tide is not double of the neap tide, and in other places it is more than quadruple. This prevented Bernoulli from attempting to fix the proportion of M to S by means of the heights of the tides. Newton had, however, done it by the tides at Bristol, and made the lunar force almost five times greater than the solar force. But this was very ill-founded, for the reason now given.

Yet Bernoulli saw, that in all places the tides gradually decreased from the syzigies to the quadratures. He therefore presumed, that they decreased by a similar law with the theoretical tides, and has given a very ingenious method of accommodating the theory to any tides which may be observed. Let A be the spring tide, and B the neap tide in any place. Then form an M and an S from these, by making $M=\frac{A+B}{2}$, and $S=\frac{A-B}{2}$; so that $M+S$ may be $=A$, and $M-S=B$ agreeable to the theory. Then with this M and S compose the general tide T, agreeable to the construction of the problem. We may be persuaded that the result cannot be far from the truth. The following table is calculated for the three chief distances of the moon from the earth.

Elong. ☽ & ☉.	Height of the Tide.		
	Moon in Perigee.	Moon in M Dist.	Moon in Apogee.
0	0.99A+0.15B	0.88A+0.12B	0.79A+0.08B
10	1.10A+0.04B	0.97A+0.03B	0.87A+0.02B
20	1.14A+0.00B	1.00A+0.00B	0.90A+0.00B
30	1.10A+0.04B	0.97A+0.03B	0.87A+0.02B
40	0.99A+0.15B	0.88A+0.12B	0.79A+0.08B
50	0.85A+0.32B	0.75A+0.25B	0.68A+0.18B
60	0.67A+0.53B	0.59A+0.41B	0.53A+0.29B
70	0.46A+0.75B	0.41A+0.59B	0.37A+0.41B
80	0.28A+0.96B	0.25A+0.75B	0.23A+0.53B
90	0.13A+1.13B	0.12A+0.88B	0.11A+0.62B
100	0.03A+1.24B	0.03A+0.97B	0.03A+0.68B
110	0.00A+1.28B	0.00A+0.00B	0.00A+0.70B
120	0.03A+1.24B	0.03A+0.97B	0.03A+0.68B
130	0.13A+1.13B	0.12A+0.88B	0.11A+0.62B
140	0.28A+0.96B	0.25A+0.75B	0.23A+0.53B
150	0.46A+0.75B	0.41A+0.59B	0.37A+0.41B
160	0.67A+0.53B	0.59A+0.41B	0.53A+0.29B
170	0.85A+0.32B	0.75A+0.25B	0.68A+0.18B
180	0.99A+0.15B	0.88A+0.12B	0.79A+0.08B

Observe that this table is corrected for the retardation arising from the inertia of the waters. Thus when the moon is 20 degrees from the sun, the mean distance tide is 1.00A+0.00B, which is the theoretical tide corresponding to conjunction or opposition.

We have now given in sufficient detail the phenomena of the tides along the equator, when the sun and moon are both in the equator, shewing both their times and their magnitude. When we recollect that all the sections of an oblong spheroid by a plane passing through an equatorial diameter are ellipses, and that the compound tide is a combination of two such spheroids, we perceive that every section of it through the centre, and perpendicular to the plane in which the sun and moon are situated, is also an ellipse, whose shorter axis is the equatorial diameter of a spring tide. This is the greatest depression in all situations of the luminaries; and the points of greatest depression are the lower poles of every compound tide. When the luminaries are in the equator, these lower poles coincide with the poles of the earth. The equator, therefore, of every compound tide is also an ellipse: the whole circumference of which is lower than any other section of this tide, and gives the place of low water in every part of the earth. In like manner, the section through the four poles, upper and lower, gives the place of high water. These two sections are terrestrial meridians or hour circles, when the luminaries are in the equator.

4

Hence

Hence it follows, that all we have already said as to the times of high and low water may be applied to every place on the surface of the earth, when the sun and moon are in the equator. But the heights of tide will diminish as we recede from the equator. The heights must be reduced in the proportion of radius to the cosine of the latitude of the place. But in every other situation of the sun and moon all the circumstances vary exceedingly. It is very true, that the determination of the elevation of the waters in any place whatever is equally easy. The difficulty is, to exhibit for that place a connected view of the whole tide, with the hours of flood and ebb, and the difference between high and low water. This is not indeed difficult; but the process by the ordinary rules of spherical trigonometry is tedious. When the sun and moon are not near conjunction or opposition, the shape of the ocean resembles a turnip, which is flat and not round in its broadest part. Before we can determine with precision the different phenomena in connection, we must ascertain the position or attitude of this turnip; marking on the surface of the earth both its elliptical equators. One of these is the plane passing through the sun and moon, and the other is perpendicular to it, and marks the place of low water. And we must mark in like manner its first meridian, which passes through all the four poles, and marks on the surface of the earth the place of high water. The position of the greatest section of this compound spheroid is frequently much inclined to the earth's equator; nay sometimes it is at right angles to it, when the moon has the same right ascension with the sun, but a different declination. In these cases the ebb tide on the equator is the greatest possible; for the lower poles of the compound spheroid are in the equator. Such situations occasion a very complicated calculus. We must therefore content ourselves with a good approximation.

And first, with respect to the times of high water. It will be sufficient to conceive the sun and moon as always in one plane, viz. the ecliptic. The orbits of the sun and moon are never more inclined than $5\frac{1}{2}$ degrees. This will make very little difference; for when the luminaries are so situated that the great circle through them is much inclined to the equator, they are then very near to each other, and the form of the spheroid is little different from what it would be if they were really in conjunction or opposition. It will therefore be sufficient to consider the moon in three different situations.

1. In the equator. The point of highest water is never farther from the moon than 15°, when she is in apogee, and the sun in perigee. Therefore if a meridian be drawn through the point of highest water to the equator, the arch *m h* of fig. 4. will be represented on the equator by another arch about $\frac{92}{100}$ of this by reason of the inclination of the equator and ecliptic. Therefore to have the time of high water, multiply the numbers of the columns which express the difference of high water and the moon's southing by $\frac{92}{100}$, and the products give the real difference.

2. Let the moon be in her greatest declination. The arch of right ascension corresponding to *m h* will be had by multiplying *m h*, or the time corresponding to it in the table, by $\frac{102}{91}$.

3. When the moon is in a middle situation between these two extremes, the numbers of the table will give the right ascension corresponding to *m h* without any correction, the distance from the equator compensating for the obliquity of the ecliptic arch *m h*.

The time of low water is not so easily found; and we must either go through the whole trigonometrical process, or content ourselves with a less perfect approximation. The trigonometrical process is not indeed difficult: we must find the position of the plane through the sun and moon. A great circle through the moon perpendicular to this is the line of high water; and another perpendicular circle cutting this at right angles is the circle of low water.

But it will be abundantly exact to consider the tide as accompanying the moon only.

Let NQSE (fig. 7.) be a section of the terraqueous globe, of which N and S are the north and south poles and EOQ the equator. Let the moon be in the direction OM, having the declination BQ. Let D be any place on the earth's surface. Draw the parallel LDC of latitude. Let B'F *b'f* be the ocean, formed into a spheroid, of which B *b* is the axis and *f*E the equator. Fig. 7.

As the place D is carried along the parallel CDL by the rotation of the earth, it will pass in succession through different depths of the watery spheroid. It will have high water when at C and L, and low water when it crosses the circle *f*OF. Draw the meridian N *d* G, and the great circle B *d b*. The arch GQ, when converted into lunar hours (each about 62 minutes), gives the duration of the flood *d c* and of the subsequent ebb *c d*, which happen while the moon is above the horizon: and the arch EG will give the durations of the flood and of the ebb which happen when the moon is below the horizon. It is evident, that these two floods and two ebbs have unequal durations. When D is at C it has high water, and the height of the tide is CC'. For, the spheroid is supposed to touch the sphere on the equator *f* OF, so that of CC' is the difference between high and low water. At L the height of the tide is LL'; and if we describe the circle LN *q*, C *q* is the difference of these high waters, or of these tides.

Hence it appears, that the two tides of one lunar day may be considerably different, and it is proper to distinguish them by different names. We shall call that a *superior tide* which happens when the moon is above the horizon during high water. The other may be called the *inferior tide*. The duration of the superior tide is measured by 2GQ, and that of the inferior tide by 2EG; and 4GO measures the difference between the whole duration of a superior and of an inferior tide.

From this construction we may learn in general,

1. When the moon has no declination, the durations and also the heights of the superior and inferior tides are equal in all parts of the world. For in this case the tide equator *f*F coincides with the meridian NOS, and the poles B'*b'* of the watery spheroid are on the earth's equator.

2. When the moon has declination, the duration and also the height of a superior tide at any place is greater than that of the inferior; or is less than it, according as the moon's declination and the latitude of the place are of the same or opposite names.

This is an important circumstance. It frequently happens that the inferior tide is found the greatest when it should be the least; which is particularly the case at the Nore. This shows, without further reasoning, that the tide at the Nore is only a branch of the regular tide.

Tide.

tide. The regular tide comes in between Scotland and the continent; and after travelling along the coast reaches the Thames, while the regular tide is just coming in again between Scotland and the continent.

3. If the moon's declination is equal to the colatitude of the place, or exceeds it, there will be only one tide in a lunar day. It will be a superior or an inferior tide, according as the declination of the moon and the latitude of the place are of the same or opposite kinds. For the equator of the tide cuts the meridian in f and F. Therefore a place which moves in the parallel cf has high water when at c, and 12 lunar hours afterwards has low water when at f. And any place k which is still nearer to the pole N has high water when at k, and 12 lunar hours afterwards has low water at m. Therefore, as the moon's declination extends to 30°, all places farther north or south than the latitude 60° will sometimes have only one tide in a lunar day.

4. The sine of the arch GO, which measures ¼th of the difference between the duration of a superior and inferior tide, is = tan. lat. × tan. decl. For in the spherical triangle dOG

Rad. : cotan. dOG = tan. dG : sin. GO, and
Sin. GO = tan. dOQ × tan. dG, = tan. decl. × tan. lat.

Hence we see, that the difference of the durations of the superior and inferior tides of the same day increase both with the moon's declination and with the latitude of the place.

The different situations of the moon and of the place of observation affect the heights of the tides no less remarkably. When the point D comes under the meridian NBQ in which the moon is situated, there is a superior high water, and the height of the tide above the low water of that day is CC'. When D is at L, the height of the inferior tide is LL'. The elevation above the inscribed sphere is $M \times \cos.^2 y$, y being the zenith distance of the moon at the place of observation. Therefore at high water, which by the theory is in the place directly under the moon, the height of the tide is as the square of the cosine of the moon's zenith or nadir distance.

Hence we derive a construction which solves all questions relating to the height of the tides with great facility, free from all the intricacy and ambiguities of the algebraic analysis employed by Bernoulli.

Fig. 8. With the radius CQ=M (the elevation produced by the moon above the inscribed sphere) describe the circle pQPE (fig. 8.) to represent a meridian, of which P and p are the poles, and EQ the equator. Bisect CP in O; and round O describe the circle PBCD. Let M be the place over which the moon is vertical, and Z be the place of observation. MQ is the moon's declination, and ZQ is the latitude of the place. Draw MCm, ZCN, cutting the small circle in A and B. Draw AGI perpendicular to CP, and draw CIμ, which will cut off an arch Eμ=QM. MZ and μ N are the moon's zenith and nadir distances. Draw the diameter BD, and the perpendiculars IK, GH, and AF. Also draw OA, PA, AB, ID.

Then DF is the superior tide, DK is the inferior tide, and DH is the arithmetical mean tide.

For the angles BCA, BDA, standing on BA, are equal. Also the angles IDB, μCN, are equal, being supplements of the angle ICB. Therefore, if BD be made radius, DA and DI are the sines of the zenith and nadir distances of the moon.

But BD : DA = DA : DF. Therefore DF = $M \times \cos.^2 y$, = the height Zz of the superior tide. Also DK=M · $\cos.^2 y'$, = the height nn' of the inferior tide.

Also, because IA is bisected in G, KF is bisected in H, and $DH = \frac{DK+DF}{2}$, = the medium tide.

Let us trace the relation of the consequences of the various positions of Z and M, as we formerly considered the results of the various situations of the sun and moon.

First, then, let Z retain its place, and let M gradually approach it from the equator. When M is in the equator, A and I coincide with C, and the three points F, K, and H, coincide in i.

As M approaches to Z, A and I approach to B and D; DF increases, and DK diminishes. The superior or inferior time is greatest when the moon is in M or in N; and DF is then = M. As the moon passes to to the northward of the place, the superior and inferior tides both diminish till I comes to D; at which time MQ is equal to ZP, and there is no inferior tide. This however cannot happen if z P is greater than 30°, because the moon never goes farther from the equator. M still going north, we have again a perpendicular from I on BD, but below I, indicating that the inferior tide, now measured by DK, belongs to the hemispheroid next the moon. Also, as M advances from the equator northward, DH diminishes continually. First, while H lies between O and B, because G approaches O; and afterwards, when G is above O and H lies between O and D. It is otherwise, however, if ZQ is greater than 45"; for then DB is inclined to EQ the other way, and DH increases as the point G rises.

In the next place, let M retain its position, and Z proceed along the meridian.

Let us begin at the equator, or suppose Q the place of observation. BD then coincides with CP, and the three lines DF, DK, and DH, all coincide with PG, denoting the two equal tides Qq and Ee and their medium, equal to either. As Z goes northward from Q, BOD detaches itself from COP; the line DF increases, while DK and DH diminish. When Z has come to M, F and B coincide with A, and DK and DH are still more diminished. When Z passes M, all the three lines DF, DK, and DH, continue to diminish. When Z comes to latitude 45°, DB is parallel to IA and EQ, and the point H coincides with O. This situation of Z has the peculiar property that DH (now DO) is the same, whatever be the declination of the moon. For IA being always parallel to DB, OK and OF will be equal, and DO will be half of DK and DF, however they may vary. When Z gets so far north that ZP is = MQ, the diameter bd falls on I; so that dk vanishes, and we have only df. And when Z goes still farther north, dk appears on the other side of I. When Z arrives at the pole, BD again coincides with PC, D with C, and DF, DK, and DH, coincide with CG.

These variations of the points F, K, and H, indicate the following phenomena.

1. The

Fig. 1.

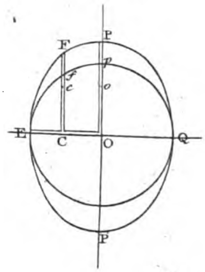


Fig. 2.

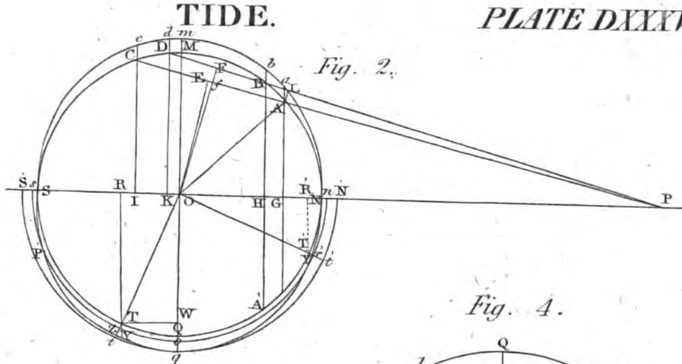


Fig. 3.

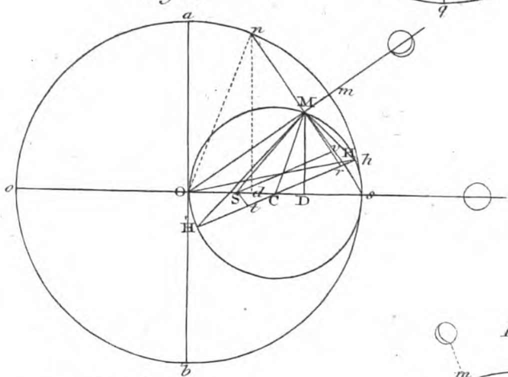


Fig. 4.

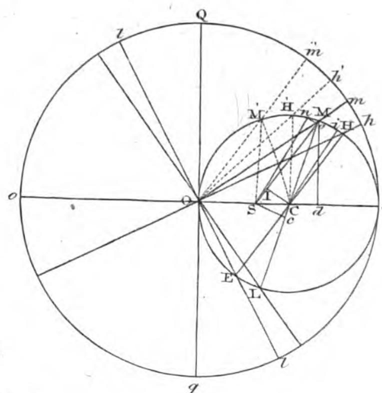


Fig. 5.

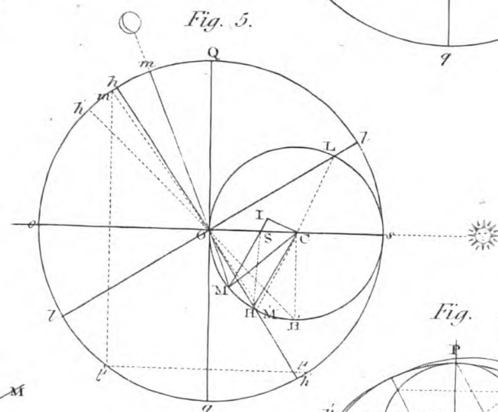


Fig. 6.

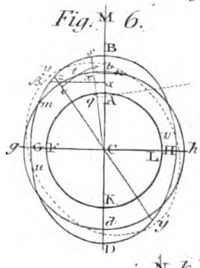


Fig. 7.

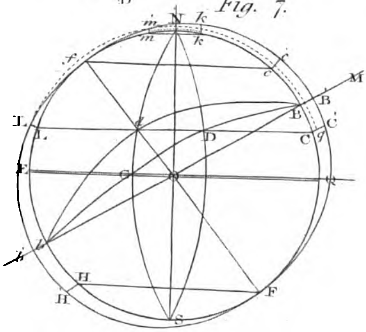
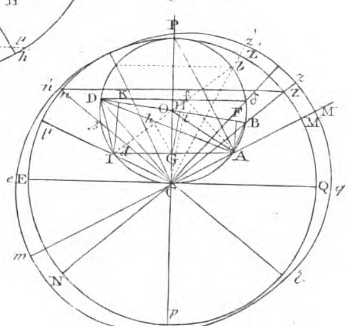


Fig. 8.



W. Train Sculp.

Tide.

1. The greatest tides happen when the moon is in the zenith or nadir of the place of observation; for then the point B coincides with A, and DF becomes DB; that is, $=$ M, indicating the full tide BB'.

2. When the moon is in the equator, the superior and inferior tides have equal heights, $= M \cdot \cos.^2$ lat. For then A and I coincide with C, and the points F and K coincide in i, and D i is $= DB \cdot \cos.^2 BDC, = M \cdot \cos.^2$ lat.

3. If the place of observation is in the equator, the inferior and superior tides are again equal, whatever is the moon's declination: For then B coincides with C, and the points F, K, and H, coincide with G; and PG $\times PC \cdot \cos.^2 APG, = M \cdot \cos.^2$ decl. moon.

4. The superior tides are greater or less than the inferior tides according as the latitude and declination are of the same or of opposite names. For by making Qζ $=$ QZ, and drawing ζ C n, cutting the small circle in β, we see that the figure is reversed. The difference between the superior and inferior tides is KF, or IA $\times$ cosin. of the angle formed by IA and DB; that is, of the angle BDδ, which is the complement of twice ZQ; because BOC $=$ 2 ZCQ. Now IA is 2 GA, $=$ 2 OA $\cdot$ sin. 2 MQ $=$ PC $\cdot$ sin. 2 MQ, $=$ M. $\cdot$ sin. 2 decl. Therefore the difference of the superior and inferior tides is M $\cdot$ sin. 2 declin. sin. 2 lat.

5. If the colatitude be equal to the declination, or less than it, there will be no inferior tide, or no superior tide, according as the latitude of the place and declination of the moon are of the same or opposite names.

For when PZ $=$ MQ, D coincide with I, and IK vanishes. When PZ is less than MQ, the point D is between C and I, and the point Z never passes through the equator of the watery spheroid; and the low water of its only tide is really the summit of the inferior tide.

6. At the pole there is no daily tide: but there are two monthly tides $= M \cdot \sin.^2$ declin. and it is low water when the moon is in the equator.

7. The medium tide, respresented by DH, is $= M \times \frac{1 + \cos.\ 2\,\text{lat.} \times \cos.\ 2\,\text{declin.}}{2}$. For DH $=$ DO $+$ OH. Now OH is equal to OG $\times$ cos. GOH $=$ OG $\cdot$ cos. 2ZQ. And OG $=$ OA $\cdot$ cos. GOA, $=$ OA $\cdot$ cos. 2MQ. Therefore OH $=$ OA $\cdot$ cos. 2ZQ $\cdot$ cos. 2MQ, Therefore DH $=$ OA $+$ OA $\cdot$ cos. 2ZQ $\cdot$ cos. 2MQ $=$

$$M \times \frac{1 + \cos.\ 2ZQ \cdot \cos.\ 2MQ}{2}.$$

Let this for the future be called m.

N. B. The moon's declination never exceeds 30°. Therefore cos. 2MQ is always a positive quantity, and never less than $\frac{1}{2}$, which is the cosine of 60°. While the latitude is less than 45°, cos. 2 lat. is also a positive quantity. When it is precisely 45°, the cosine of its double is *o*; and when it is greater than 45°, the cosine of its double is negative. Hence we see,

1. That the medium tides are equally affected by the northern and southern declinations of the moon.

2. If the latitude of the place is 45°, the medium tide is always $\frac{1}{2}$ M. This is the reason why the tides along the coasts of France and Spain are so little affected by the declination of the moon.

3. If the latitude is less than 45°, the mean tides increase as the moon's declination diminishes. The contrary happens if ZQ is greater than 45°. For DH increases or diminishes while the point G separates from C according as the angle COD is greater or less than COB; that is, according as PCZ is greater or less than ZCQ.

4. When Z is in the equator, H coincides with G, and the effect of the moon's declination on the height of the tides is the most sensible. The mean tide is then $= M \frac{1 + \cos.\ 2\,MQ}{2}$.

All that we have now said may be said of the solar tide, putting S in place of M.

Also the same things hold true of spring tides, putting M$+$S in place of M.

But in order to ascertain the effects of declination and latitude on other tides, we must make a much more complicated construction, even though we suppose both luminaries in the ecliptic. For in this case the two depressed poles of the watery spheroid are not in the poles of the earth; and therefore the sections of the ocean, made by meridians, are by means ellipses.

In a neap tide, the moon is vertical at B (fig. 7. or 8.), and the sun at some point of fF, 90° from B. If O be this point, the construction for the heights of the tides may be made by adding to both the superior and inferior tides for any point D, the quantity $\overline{M + S - DF}$ or DK $\times \sin.^2 d\,O, = \overline{M + S - \text{tide}} \times \frac{\sin.^2 2Q}{\cos.^2 MQ}$, as is evident. Fig. 7. or 8.

But if the sun be vertical at d, d will be the highest part of the circle fOF, and no correction is necessary. But in this case the circle of high water will be inclined to the meridian in an angle equal to dBO (fig. 7.), and neither the times nor elevations of high water will be properly ascertained, and the error in time may be considerable in high latitudes.

The inaccuracies are not so great in intermediate tides, and respect chiefly the time of high water and the height of low water.

The exact computation is very tedious and peculiar, so that it is hardly possible to give any account of a regular progress of phenomena; and all we can do is, to ascertain the precise heights of detached points. For which reasons, we must content ourselves with the construction already given. It is the exact geometrical expression of Bernoulli's analysis, and its consequences now related contain all that he has investigated. We may accommodate it very nearly to the real state of things, by supposing PC equal, not to CO of fig. 4. but to MS, exhibiting the whole compound tide. And the point B, instead of representing the moon's place, must represent the place of high water.

Thus have we obtained a general, though not very accurate, view of the phenomena which must take place in different latitudes and in different declinations of the sun and moon, provided that the physical theory which determines the form and position of the watery spheroid be just. We have only to compute, by a very simple process of spherical trigonometry, the place of the pole of this spheroid. The second construction, in fig. 8. shows us all the circumstances of the time and height of high water at any point. It will be recollected, that in computing this place of the pole, the anticipation of 20 degrees, arising from the inertia of the waters, must be attended to.

Were we to institute a comparison of this theory with observation, without farther consideration, we should still find it unfavourable, partly in respect of the heights of the tides, and more remarkably in respect of the time of low water. We must again consider the effects of the inertia of the waters, and recollect, that a regular theoretical tide differs very little in its progress from the motion of a wave. Even along the free ocean, its motion much resembles that of any other wave. All waves are propagated by an oscillatory motion of the waters, precisely similar to that of a pendulum. It is well known, that if a pendulum receive a small impulse in the time of every descent, its vibrations may be increased to infinity. Did the successive actions of the sun or moon just keep time with the natural propagation of the tides, or the natural oscillations of the waters, the tides would also augment to infinity: But there is an infinite odds against this exact adjustment. It is much more probable that the action of to-day interrupts or checks the oscillation produced by yesterday's action, and that the motion which we perceive in this day's tide is what remains, and is compounded with the action of to-day. This being the case, we should expect that the nature of any tide will depend much on the nature of the preceding tide. Therefore we should expect that the superior and inferior tides of the same day will be more nearly equal than the theory determines. The whole course of observation confirms this. In latitude 45°, the superior and inferior tides of one day may differ in the proportion of $2\frac{1}{2}$ to 1, and the tides corresponding to the greatest and least declinations of the moon may differ nearly as much. But the difference of the superior and inferior tides, as they occur in the list of Observations at Rochefort, is not the third part of this, and the changes made by the moon's declination is not above one-half. Therefore we shall come much nearer the true measure of a spring tide, by taking the arithmetical mean, than by taking either the superior or inferior.

We should expect less deviation from the theory in the gradual diminution of the tides from spring tide to neap tide, and in the gradual changes of the medium tide by the declination of the moon; because the successive changes are very small; and when they change in kind, that is, diminish after having for some time augmented, the change is by insensible degrees. This is most accurately confirmed by observation. The vast collection made by Cassini of the observations at Brest being examined by Bernoulli, and the medium of the two tides in one day being taken for the tide of that day, he found such an agreement between the progression of these medium tides and the progression of the lines MS of fig. 4. that the one seemed to be calculated by the other. He found no less agreement in the changes of the medium tide by the moon's declination.

In like manner, the changes produced by the different distances of the moon from the earth, were found abundantly conformable to the theory, although not so exact as the other. This difference or inferiority is easily accounted for: When the moon changes in her mean distance, one of the neap tides is uncommonly small, and therefore the successive diminutions are very great, and one tide sensibly affects another. The same circumstance operates when she changes in apogee, by reason of a very large spring tide. And the changes corresponding both to the sun's distance from the earth and his declination agreed almost exactly.

All these things considered together, we have abundant reason to conclude, that not only the theory itself is just in principle (a thing which no intelligent naturalist can doubt), but also that the data which are assumed in the application are properly chosen; that is, that the proportion of two to five is very nearly the true proportion of the mean solar and lunar forces. If we now compute the medium tide for any place in succession, from spring tide to neap tide, and still more, if we compute the series of times of their occurrence, we shall find as great an agreement as can be desired. Not but that there are many irregularities; but these are evidently so anomalous, that we can ascribe them to nothing but circumstances which are purely local.

This general rule of computation must be formed in the following manner:

The spring tide, according to theory, being called A, and the neap tide B, recollect that the spring tide, according to the regular theory, is measured by M + S. Recollect also, that when the lunar tide only is considered the superior spring tide is $M \times \sin.^2, ZM$ (fig. 8.). But when we consider the action of two adjoining tides on each other, we find it safer to take the medium of the superior and inferior tides for the measure; and this is $M \times \frac{1 + \cos.^2 2ZQ \times \cos. 2MQ}{2}$. Let this be called m. This being totally the effect of M as modified by latitude and declination, may be taken as its proper measure, by which we are to calculate the other tides of the monthly series from spring tide to neap tide.

In like manner, we must compute a value for S, as modified by declination and latitude; call this s. Then say,

$$M+S : A = m+s : A \times \frac{m+s}{M+S}.$$

This fourth proportional will give the spring tide as modified for the given declination of the luminaries, and the latitude of the place.

Now recollect, that the medium tide, when the luminaries are in the equator, is $A \times \cos.^2$ lat. Therefore let F be the spring tide *observed* at any place when the luminaries are in the equator; and let this be the medium of a great many observations made in these circumstances. This gives $A \cdot \cos.^2$ lat. (as modified by the peculiar circumstances of the place) = F. Therefore the fourth proportional now given changes to $F \times \frac{m+s}{\overline{M+S} \cdot \cos.^2 \text{lat.}}$. And a similar substitute for B is $G + \frac{m-s}{\overline{M-S} \cdot \cos.^2 \text{lat.}}$.

Lastly, To accommodate our formulæ to every distance of the earth from the sun and moon, let D and Δ be the mean distances of the sun and moon, and d and δ their distances at the given time; and then the two substitutes become

$$\frac{\Delta^3 d^3 M + \delta^3 D^3 S}{d^3 \delta^3 (M+S)} \times F \times \frac{m+s}{(M+S) \cos.^2 \text{lat.}}$$

$$\frac{\Delta^3 d^3 M - \delta^3 D^3 S}{d^3 \delta^3 (M-S)} \times G \times \frac{m+s}{(M-S) \cos.^2 \text{lat.}}.$$

The

Tide.

The half sum of these two quantities will be the MC, and their half difference will be the SC, of fig. 4. with which we may now operate, in order to find the tide for any other day of the menstrual series, by means of the elongation a of the moon from the sun; that is, we must say $MC+CS : MC-CS = \tan. a : \tan. b$; then $x = \frac{a+b}{2}$, and $y = \frac{a-b}{2}$. And MS, the height of the tide, is $MC \times \cos. 2y + CS \times \cos. 2x$.

SUCH is the general theory of the tides, deduced from the principle of universal gravitation, and adjusted to that proportion of the solar and lunar forces which is most consistent with other celestial phenomena. The comparison of the greatest and least daily retardations of the tides was with great judgment preferred to the proportion of spring and neap tides, selected by Sir Isaac Newton for this purpose. This proportion must depend on many local circumstances. When a wave or tide comes to the mouths of two rivers, and sends a tide up each, and another tide of half the magnitude comes a fortnight after; the proportion of tides sent up to any given places of these rivers may be extremely different. Nay, the proportion of tides sent up to two distant places of the same river can hardly be the same; nor are they the same in any river that we know. It can be demonstrated, in the strictest manner, that the farther we go up the river, where the declivity is greater, the neap tide will be smaller in proportion to the spring tide. But it does not appear that the time of succession of the different tides will be much affected by loyal circumstances. The tide of the second day of the moon being very little less than that of the first, will be nearly as much retarded, and the intervals between their arrivals cannot be very different from the real intervals of the undisturbed tides; accordingly, the succession of the highest to the highest but one is found to be the same in all places, when not disturbed by *different* winds. In like manner the succession of the lowest and the lowest but one is found equally invariable; and the highest and the lowest tides observed in any place *must* be accounted the spring and neap tides of that place, whether they happen on the day of full and half moon or not. Nay, we can see here the explanation of a general deviation of the theory which we formerly noticed. A low tide, being less able to overcome obstructions, will be sooner stopped, and the neap tides should happen a little earlier than by the undisturbed theory.

With all these corrections, the theory now delivered will be found to correspond with observation, with all the exactness that we can reasonably expect. We had an opportunity of comparing it with the phenomena in a place where they are very singular, viz. in the harbour of Bissestedt in Iceland. The equator of the watery spheroid frequently passes through the neighbourhood of this place, in a variety of positions with respect to its parallel of diurnal revolution, and the differences of superior and inferior tides are most remarkable and various. We found a wonderful conformity to the most diversified circumstances of the theory.

There is a period of 18 years, respecting the tides in Iceland, taken notice of by the ancient Saxons; but it is not distinctly described. Now this is the period of the moon's nodes, and of the greatest and least inclination of her orbit to the equator. It is therefore the period of the positions of the equator of the tides which ranges round this island, and very sensibly affects them.

Hitherto we have supposed the tides to be formed on an ocean completely covering the earth. Let us see how those may be determined which happen in a small and confined sea, such as the Caspian or the Black sea. The determination in this case is very simple. As no supply of water is supposed to come into the bason, it is susceptible of a tide only by sinking at one end and rising at the other. This may be illustrated by fig. 6. where C s, C y, are two perpendicular planes bounding a small portion of the natural ocean. The water will sink at z and rise at x, and form a surface $o\,t\,r$ parallel to the equilibrated surface $y\,s$. It is evident that there will be high water, or the greatest possible rise, at r, when the bason comes to that position where the tangent is most of all inclined to the diameter. This will be when the angle t CB is 45° nearly, and therefore three lunar hours after the moon's southing; at the same time, it will be low water at the other end. It is plain that the rise and fall must be exceedingly small, and that there will be no change in the middle. The tides of this kind in the Caspian sea, in latitude 45°, whose extent in longitude, does not exceed eight degrees are not above seven inches; a quantity so small, that a slight breeze of wind is sufficient to check it, and even to produce a rise of the waters in the opposite direction. We have not met with any accounts of a tide being observed in this sea.

It should be much greater, though still very small, in the Mediterranean sea. Accordingly, tides are observed there, but still more remarkably in the Adriatic, for a reason which will be given by and by. We do not know that tides have been observed in the great lakes of North America. These tides, though small, should be very regular.

Should there be another great bason in the neighbourhood of $z\,x$, lying east or west of it, we should observe a curious phenomenon. It would be low water on one side of the shore z when it is high water on the other side of this partition. If the tides in the Euxine and Caspian seas, or in the American lakes which are near each other could be observed, this phenomenon should appear, and would be one of the prettiest examples of universal gravitation that can be conceived. Something like it is to be seen at Gibraltar. It is high water on the east side of the rock about 10 o'clock at full and change, and it is high water on the west side not a mile distant, at 12. This difference is perhaps the chief cause of the singular current which is observed in the straits mouth. There are three currents observed at the same time which change their directions every 12 hours. The small tide of the Mediterranean proceeds along the Barbary shore, which is very uniform all the way from Egypt, with tolerable regularity, But along the northern side, where it is greatly obstructed by Italy, the islands, and the east coast of Spain, it sets very irregularly; and the perceptible high water on the Spanish coast differs four hours from that of the southern coast. Thus it happens, that one tide ranges round Europa point, and another along the shore near Ceuta, and there is a third current in the middle different from both. Its general direction is from the

Tide.

Atlantic ocean into the Mediterranean sea, but it sometimes comes out when the ebb tide in the Atlantic is considerable.

Suppose the moon over the middle of the Mediterranean. The surface of the sea will be level, and it will be half tide at both ends, and therefore within the Straits of Gibraltar. But without the Straits it is within half an hour of high water. Therefore there will be a current setting *in* from the Atlantic. About three and a half hours after, it is high water within and half ebb without. The current now sets out from the Mediterranean. Three hours later, it is low water without the Straits and half ebb within; therefore the current has been setting out all this while. Three hours later, it is half flood without the Straits and low water within, and the current is again setting in, &c.

Were the earth fluid to the centre, the only sensible motion of the waters would be up and down, like the waves on the open ocean, which are not brushed along by strong gales. But the shallowness of the channel makes a horizontal motion necessary, that water may be supplied to form the accumulation of the tide. When this is formed on a flat shelving coast, the water must flow in and out, on the flats and sands, while it rises and falls. These horizontal motions must be greatly modified by the channel or bed along which they move. When the channel contracts along the line of flowing water, the wave, as it moves up the channel, and is checked by the narrowing shores, must be reflected back, and keep a-top of the waters still flowing in underneath. Thus it may rise higher in these narrow seas than in the open ocean. This may serve to explain a little the great tides which happen on some coasts, such as the coast of Normandy. At St Malo the flood frequently rises 50 feet. But we cannot give any thing like a full or satisfactory account of these singularities. In the bay of Fundy, and particularly at Annapolis Royal, the water sometimes rises above 100 feet. This seems quite inexplicable by any force of the sun and moon, which cannot raise the waters of the free ocean more than eight feet. These great floods are unquestionably owing to the proper timing of certain oscillations or currents adjoining, by which they unite, and form one of great force. Such violent motions of water are frequently seen on a small scale in the motions of brooks and rivers; but we are too little acquainted with hydraulics to explain them with any precision.

We have seen that there is an oscillation of waters formed under the sun and moon; and that in consequence of the rotation of the earth, the inertia and the want of perfect fluidity of the waters, and obstructions in the channel, this accumulation never reaches the place where it would finally settle if the earth did not turn round its axis. The consequence of this must be a general current of the waters from east to west. This may be seen in another way. The moon in her orbit round the earth has her gravity to the earth diminished by the sun's disturbing force, and therefore moves in an orbit less incurvated than she would describe independent of the sun's action. She therefore employs a longer time. If the moon were so near the earth as almost to touch it, the same thing would happen. Therefore suppose the moon turning round the earth, almost in contact with the equator, with her natural undisturbed periodic time, and that the earth is revolving round its axis in the same time, the moon would remain continually above the same spot of the earth's surface (suppose the city of Quito), and a spectator in another planet would see the moon always covering the same spot. Now let the sun act. This will not affect the rotation of the earth, because the action on one part is exactly balanced by the action on another. But it will affect the moon. It will move more slowly round the earth's centre, and at a greater distance. It will be left behind by the city of Quito, which it formerly covered. And as the earth moves round from west to east, the moon, moving more slowly, will have a motion to the west with respect to Quito. In like manner, every particle of water has its gravity diminished, and its diurnal motion retarded; and hence arises a general motion or current from east to west. This is very distinctly perceived in the Atlantic and Pacific oceans. It comes round the Cape of Good Hope, ranges along the coast of Africa, and then sets directly over to America, where it meets a similar stream which comes in by the north of Europe. Meeting the shores of America, it is deflected both to the south along the coast of Brazil, and to the north along the North American shores, where it forms what is called the *Gulf Stream*, because it comes from the gulf of Mexico. This motion is indeed very slow, this being sufficient for the accumulation of seven or eight feet on the deep ocean; but it is not altogether insensible.

We may expect differences in the appearances on the western shores of Europe and Africa, and on the western shore of America, from the appearances on the eastern coasts of America and of Asia, for the general current obstructs the waters from the western shores, and sends them to the eastern shores. Also when we compare the wide opening of the northern extremity of the Atlantic ocean with the narrow opening between Kamtschatka and America, we should expect differences between the appearances on the west coasts of Europe and of America. The observations made during the circumnavigations of Captain Cook and others show a remarkable difference. All along the west coast of North America the inferior tide is very trifling, and frequently is not perceived.

In the very same manner, the disturbing forces of the sun and moon form a tide in the fluid air which surrounds this globe, consisting of an elevation and depression, which moves gradually from east to west. Neither does this tide ever attain that position with respect to the disturbing planets which it would do were the earth at rest on its axis. Hence arises a motion of the whole air from east to west; and this is the principal cause of the trade-winds. They are a little accelerated by being heated, and therefore expanding. They expand more to the westward than in the opposite direction, because the air expands on that side into air which is now cooling and contracting. These winds very evidently follow the sun's motion, tending more to the south or north as he goes south or north. Were this motion considerably affected by the expansion of heated air, we should find the air rather coming northward and southward from the torrid zone, in consequence of its expansion in that climate. We repeat it, it is almost solely produced by the aerial tide, and is necessary for the very formation of this tide. We cannot perceive the accumulation. It cannot affect the barometer, as many

many think, because, though the air becomes deeper, it becomes deeper only when it is made lighter by the gravitation to the sun. Instead of pressing more on the cistern of the barometer, we imagine that it presses less; because, like the ocean, it never attains the height to which it tends. It remains always too low for equilibrium, and therefore it should press with less force on the cistern of a barometer.

There is an appearance precisely similar to this in the planet Jupiter. He is surrounded by an atmosphere which is arranged in zones or belts, probably owing to climate differences of the different latitudes, by which each seems to have a different kind of sky. Something like this will appear to a spectator in the moon looking at this earth. The general weather and appearance of the sky is considerably different in the torrid and temperate zones. Jupiter's belts are not of a constant shape and colour; but there often appear large spots or tracts of cloud, which retain their shape during several revolutions of Jupiter round his axis. To judge of his rotation by one of these, we should say that he turns round in 9.55. There is also a brighter spot which is frequently seen, occupying one certain situation on the body of Jupiter. This is surely adherent to his body, and is either a bright-coloured country, or perhaps a tract of clouds hovering over some volcano. This spot turns round in $9.51\frac{1}{2}$. And thus there is a general current in his atmosphere from east to west.

Both the motion of the air and of the water tend to diminish the rotation of the earth round its axis; for they move slower than the earth, because they are retarded by the luminaries. They must communicate this retardation to the earth, and must take from it a quantity of motion precisely equal to what they want, in order to make up the equilibrated tide. In all probability this retardation is compensated by other causes; for no retardation can be observed. This would have altered the length of the year since the time of Hipparchus, giving it a smaller number of days. We see causes of compensation. The continual washing down of soil from the elevated parts of the earth must produce this effect, by communicating to the valley on which it is brought to rest the excess of diurnal velocity which it had on the mountain top.

While we were employed on this article, a book was put into our hands called *Studies of Nature*, by a Mr Saint Pierre. This author scouts the Newtonian theory of the tides, as erroneous in principle, and as quite insufficient for explaining the phenomena; and he ascribes all phenomena of the tides to the liquefaction of the ices and snows of the circumpolar regions, and the greater length of the polar than of the equatorial axis of the earth. He is a man of whom we wish to speak with respect, for his constant attention to final causes, and the proof thence resulting of the wisdom and goodness of God. For this he is entitled to the greater praise, that it required no small degree of fortitude to resist the influence of national example, and to retain his piety in the midst of a people who have drunk the very dregs of the atheism of ancient Greece. This is a species of merit rarely to be met with in a Frenchman of the present day; but as a philosopher, M. de St Pierre can lay claim to no other merit except that of having collected many important facts. The argument which he employs to prove that the earth is a prolate spheroid, is a direct demonstration of the truth of the contrary opinion; and the melting of the ice and snows at the poles cannot produce the smallest motion in the waters. Were there even ten times more ice and snow floating on the northern sea than there is, and were it all to melt in one minute, there would be no flux from it; for it would only fill up the space which it formerly occupied in the water. Of this any person will be convinced, who shall put a handful of snow squeezed hard into a jar of water, and note the exact height of the water. Let the snow melt, and he will find the water of the same height as before.

Tide-Waiters, or *Tidesmen*, are inferior officers belonging to the customhouse, whose employment is to watch or attend upon ships until the customs be paid: they get this name from their going on board ships on their arrival in the mouth of the Thames or other ports, and so come up with the tide.

TIEND in *Scots Law*. See TEIND.

TIERCE, or TEIRCE, a measure of liquid things, as wine, oil, &c. containing the third part of a pipe, or 42 gallons.

TIERCED, in *Heraldry*, denotes the shield to be divided by any part of the partition lines, as party, coupy, tranchy, or tailly, into three equal parts of different colours or metals.

TIGER. See FELIS, MAMMALIA *Index*.

TIGER-Wolf, the name of the hyæna at the Cape of Good Hope. See CANIS, MAMMALIA *Index*.

TIGRIS, a river of Asia, which has its source near that of the Euphrates in the mountain Tchildir in Turkomania: afterwards it separates Diarbeck from Erzerum, and Khusistan from Irac-Arabia; and uniting with the Euphrates at Gorno, it falls into the gulf of Bassorah, under the name of *Schat el-Arab*. This river passes by Diarbekir, Gezira, Mousul, Bagdad, Gorno, and Bassorah.

TILIA, LIME or LINDEN TREE, a genus of plants belonging to the class of polyandria; and in the natural system ranging under the *Columniferæ*. See BOTANY *Index*.

TILLEMONT, SEBASTIAN LE NAIN DE. See NAIN.

TILLER *of a Ship*, a strong piece of wood fastened in the head of the rudder, and in small ships and boats called the *helm*.

TILLOEA, a genus of plants belonging to the class of tetrandria; and in the natural system ranging under the 13th order, *Succulentæ*. See BOTANY *Index*.

TILLOTSON, JOHN, a celebrated archbishop of Canterbury, was the son of Robert Tillotson of Sowerby, in the parish of Halifax in Yorkshire, clothier; and was born there in the year 1630. He studied in Clare-hall, Cambridge; and in 1656 left this college, in order to become tutor to the son of Edmund Prideaux, Esq. of Ford abbey in Devonshire. He was afterwards curate to Dr Hacket, vicar of Cheshunt, in Hertfordshire. In 1663 he was presented by Sir Thomas Barnardiston to the rectory of Ketton or Keddington in the county of Suffolk; but was the next year chosen preacher to Lincoln's Inn, when he procured Ketton to be bestowed on his curate. He was greatly admired in London for his sermons; and in the same year was chosen Tuesday-lecturer at St Lawrence's church, London, where his lectures were frequented by all

all the divines of the city, and by many persons of quality and distinction. In 1666, he took the degree of Doctor of Divinity at Cambridge; in 1669, was made prebendary of Canterbury; in 1672, was admitted dean of that cathedral; and three years after, was made a prebendary of St Paul's cathedral, London. In 1679, he became acquainted with Charles earl of Shrewsbury, whom he converted from Popery; and the next year refused to sign the clergy of London's address of thanks to King Charles II. for not agreeing to the bill of exclusion of the duke of York. In 1683, he visited the unfortunate Lord Russel when under condemnation; and attended him in his last moments on the scaffold. In 1689, he was installed dean of St Paul's; made clerk of the closet to King William and Queen Mary; and appointed one of the commissioners to prepare matters to be laid before the convocation, in order to a comprehension of all Protestants, as well dissenters as churchmen; but this attempt was frustrated by the zeal of those members of that body, who refused to admit of any alteration in things confessedly indifferent. In 1691, Dr Tillotson was, notwithstanding the warmest remonstrances and intreaties on his part, consecrated archbishop of Canterbury, and four days after was sworn one of the privy council; their majesties always reposing an entire confidence in his prudence, moderation, and integrity. In 1694, he was seized with a palsy, of which he died in the 65th year of his age. He was interred in the church of St Lawrence Jewry, London, where a handsome monument is erected to his memory. This learned and pious divine, while living, was greatly inveighed against by the enemies of the revolution. After his death there was found a bundle of bitter libels which had been published against him, on which he had written with his own hand, "I forgive the authors of these books, and pray God that he may also forgive them." It is remarkable, that while this truly great man was in a private station, he always laid aside two-tenths of his income for charitable uses. One volume in folio of Dr Tillotson's sermons was published in his life-time, and corrected by his own hand; they were translated into French by Barbeyrac. Those which came abroad after his death, from his chaplain Dr Barker, made two volumes in folio, the copy of which was sold for 2500l. This was the only legacy he left to his family, his extensive charity having consumed his yearly revenues as constantly as they came to his hands. King William, however, gave two grants to his widow; the first of which was an annuity of 400l. during the term of her natural life, and the second of 200l. as an addition to the former annuity. Dr Tillotson wrote some other works besides his Sermons; and also published Dr Barrow's works, and Dr Wilkin's Treatise of the Principles and Duties of Natural Religion, and a volume of that divine's Sermons.

TIMBER, wood fit for building, &c. See TREE, and *STRENGTH of Materials*.

TIMBERS, the ribs of a ship, or the incurvated pieces of wood, branching outward from the keel in a vertical direction, so as to give strength, figure, and solidity, to the whole fabric. See SHIP-BUILDING, book i. chap. ii.

TIME, a succession of phenomena in the universe, or a mode of duration marked by certain periods or

measures, chiefly by the motion and revolution of the sun.

The general idea which time gives in every thing to which it is applied, is that of limited duration. Thus we cannot say of the Deity, that he exists in time; because eternity, which he inhabits, is absolutely uniform, neither admitting limitation nor succession. See METAPHYSICS, N° 209.

TIME, in *Music*, is an affection of sound, by which it is said to be long or short, with regard to its continuance in the same tone or degree of tune.

Musical time is distinguished into *common* or *duple* time, and *triple* time.

Double, *duple*, or *common* time, is when the notes are in a duple duration of each other, viz. a semibreve equal to two minims, a minim to two crotchets, a crotchet to two quavers, &c.

Common or double time is of two kinds. The first when every bar or measure is equal to a semibreve, or its value in any combination of notes of a less quantity. The second is where every bar is equal to a minim, or its value in less notes. The movements of this kind of measure are various, but there are three common distinctions; the first *slow*, denoted at the beginning of the line by the mark C; the second *brisk*, marked thus $\overline{\mathrm{C}}$; and the third *very brisk*, thus marked 𝄵.

Triple time is when the durations of the notes are triple of each other, that is, when the semibreve is equal to three minims, the minim to three crotchets, &c. and it is marked T.

TIME-Keepers, or *Instruments for measuring Time*. See CLOCK, DIAL, WATCH, &c.

Harrison's TIME-Keeper. See HARRISON and LONGITUDE.

TIMOLEON, a celebrated Corinthian general, who restored the Syracusans to their liberty, and drove the Carthaginians out of Sicily. See SYRACUSE, N° 50—54.

TIMON the *Sceptic*, who is not to be confounded with Timon the *Misanthrope*, was a Phliasian, a disciple of Pyrrho, and lived in the time of Ptolemy Philadelphus. He took so little pains to invite disciples to his school, that it has been said of him, that as the Scythians shot flying, Timon gained pupils by running from them. He was fond of rural retirement; and was so much addicted to wine, that he had a successful contest with several celebrated champions in drinking. Like Lucian, he wrote with sarcastic humour against the whole body of philosophers. The fragments of his satirical poem *Silli*, often quoted by the ancients, have been carefully collected by Henry Stephens in his *Poesis Philosophica*. Timon lived to the age of 90 years.

TIMON, surnamed *Misanthropos*, or the *Man-hater*, a famous Athenian, who lived about 420 B. C. He was one day asked, why he loved the young Alcibiades while he detested all the rest of the human race? on which he replied, "It is because I foresee that he will be the ruin of the Athenians." He carefully avoided all sorts of company; yet went one day to an assembly of the people, and cried with a loud voice, "That he had a fig-tree on which several persons had hanged themselves;

themselves; but as he intended to cut it down, in order to build a house on the place where it stood, he gave them notice of it, that if any of them had a mind to hang themselves, they must make haste and do it speedily." He had an epitaph engraved on his tomb, filled with imprecations against those who read it. Shakespeare has formed a tragedy on his story.

TIMOR, an island of Asia, in the East Indian sea, to the south of the Moluccas, and to the east of the island of Java, being 150 miles in length, and 37 in breadth. It abounds in sandal-wood, wax and honey; and the Dutch have a fort here. The inhabitants are Pagans, and are little better than savages; and some pretend they had not the use of fire many years ago.

TIMOTHEUS, one of the most celebrated poet-musicians of antiquity, was born at Miletus, an Ionian city of Caria, 446 years B. C. He was contemporary with Philip of Macedon and Euripides; and not only excelled in lyric and dithyrambic poetry, but in his performance upon the cithara. According to Pausanias, he perfected that instrument by the addition of four new strings to the seven which it had before; though Suidas says it had nine before, and that Timotheus only added two, the 10th and 11th, to that number. See Lyre.

With respect to the number of strings upon the lyre of Timotheus: The account of Pausanias and Suidas is confirmed in the famous senatus-consultum against him, still extant, preserved at full length in Boethius. Mr Stillingfleet has given an extract from it, in proof of the simplicity of the ancient Spartan music. The fact is mentioned in Athenæus; and Casaubon, in his notes upon that author, has inserted the whole original text from Boethius, with corrections. The following is a faithful translation of this extraordinary Spartan act of parliament. "Whereas Timotheus the Milesian, coming to our city, has dishonoured our ancient music, and, despising the lyre of seven strings, has, by the introduction of a greater variety of notes, corrupted the ears of our youth; and by the number of his strings, and the novelty of his melody, has given to our music an effeminate and artificial dress, instead of the plain and orderly one in which it has hitherto appeared; rendering melody infamous, by composing in the chromatic instead of the enharmonic:——————The kings and the ephori have therefore resolved to pass censure upon Timotheus for these things: and, farther, to oblige him to cut all the superfluous strings of his eleven, leaving only the seven tones; and to banish him from our city; that men may be warned for the future not to introduce into Sparta any unbecoming custom."———

The same story, as related in Athenæus, has this additional circumstance, That when the public executioner was on the point of fulfilling the sentence, by cutting off the new strings, Timotheus, perceiving a little statue in the same place, with a lyre in his hand of as many strings as that which had given the offence, and showing it to the judges, was acquitted.

It appears from Suidas, that the poetical and musical compositions of Timotheus were very numerous, and of various kinds. He attributes to him 19 nomes, or canticles, in hexameters; 36 proems, or preludes; 18 dithyrambics; 21 hymns; the poem in praise of Diana; one panegyric; three tragedies, the Persians, Phinidas, and Laertes; to which must be added a fourth, mentioned by several ancient authors, called *Niobe*, without forgetting the poem on the birth of Bacchus. Stephen of Byzantium makes him author of 18 books of nomes, or airs, for the cithara, to 8000 verses; and of 1000 Προνομια, or preludes, for the nomes of the flutes.

Timotheus died in Macedonia, according to Suidas, at the age of 97; though the Marbles, much better authority, say at 90; and Stephen of Byzantium fixes his death in the fourth year of the 105th Olympiad, two years before the birth of Alexander the Great; whence it appears, that this Timotheus was not the famous player on the flute so much esteemed by that prince, who was animated to such a degree by his performance as to seize his arms; and who employed him, as Athenæus informs us, together with the other great musicians of his time, at his nuptials. However, by an inattention to dates, and by forgetting that of these two musicians of the same name the one was a Milesian and the other a Theban, they have been hitherto often confounded.

TIMUR-beck. See Tamerlane.

TIN, a metallic substance. See Chemistry and Mineralogy *Index* for an account of its qualities and ores; and for the method of reducing its ores, see Ores, *Reduction of*.

TINCAL, the name by which crude or impure borax is sometimes known. See Borax, Chemistry *Index*.

TINCTURE, in *Pharmacy*. See Materia Medica *Index*.

TINDAL, Dr Matthew, a famous English writer, was the son of the reverend Mr John Tindal of Beer-Ferres in Devonshire, and was born about the year 1657. He studied at Lincoln college in Oxford, whence he removed to Exeter, and was afterwards elected fellow of All Souls. In 1685 he took the degree of doctor of law, and in the reign of James II. declared himself a Roman Catholic; but soon renounced that religion. After the revolution he published several pamphlets in favour of government, the liberty of the press, &c. His "Rights of the Christian Church asserted," occasioned his having a violent contest with the high-church clergy; and his treatise "Christianity as old as the Creation," published in 1730, made much noise, and was answered by several writers, particularly by Dr Conybeare, Mr Foster, and Dr Leland. Dr Tindal died at London in August 1733. He left in manuscript a second volume of his "Christianity as old as the Creation;" the preface to which has been published. Mr Pope has satirized Dr Tindal in his Dunciad.

TINDALE, William. See Tyndale.

TINNING, the covering or lining any thing with melted tin, or tin reduced to a very fine leaf. Looking-glasses are foliated or tinned with plates of beaten tin, the whole bigness of the glass, applied or fastened thereto by means of quicksilver. See *Foliating of Looking-Glasses*.

TINNITUS aurium, a noise in the ears like the continued sound of bells, very common in many disorders, particularly in nervous fevers.

TIPPERARY, a county of the province of Munster in Ireland, bounded on the west by those of Limerick and Clare, on the east by the county of Kilkenny and Queen's county, on the south by the county of Waterford, Tipperary ‖ Tirol.

Gough's edit. of Camden's Britannia.

ford, and on the north and north-east by King's-county and the territory of the ancient O'Carols. It extends about 52 miles in length, and 27 in breadth, containing 599,500 acres, divided into 12 baronies, containing 169,000 inhabitants. It sends three members to parliament, viz. two for the county, and one for Clonmell. The north part of it is mountainous and cold; but in the south the air is milder, and the soil much more fertile, producing plenty of corn, and good pasture for the numerous herds of cattle and flocks of sheep with which it abounds. The north part is called *Ormond*, and for a long time gave the title of *earl*, and afterwards of *marquis* and *duke*, to the noble family of Butler, descended from a sister of Thomas à Becket archbishop of Canterbury, till, at the accession of George I. the last duke was attainted of high-treason, and died abroad. In that part of the county, the family had great prerogatives and privileges granted them by Edward III. Another district in this county was anciently called the *County of the Holy Cross of Tipperary*, from a famous abbey in it styled *Holy Cross*, on account of a piece of Christ's cross that was said to be preserved there. The remains of the abbey, or rather the spot where it stood, are still held in great veneration. See TIPPERARY, SUPPLEMENT.

TIPSTAFF, an officer who attends the judges with a kind of staff tipped with silver, aud takes into his charge all prisoners who are committed or turned over at a judge's chambers.

TIPULA, the CRANE-FLY; a genus of insects belonging to the order of *diptera*. See ENTOMOLOGY *Index*.

TIRE, in the sea language, is a row of cannon placed along a ship's side, either above upon deck, or below, distinguished by the epithets of *upper* and *lower tires*.

TIREE, or TIREY, one of the Western islands of Scotland, 10 miles long and from one to two in breadth, contains above 2000 inhabitants, and produces sheep and black cattle, with some grain and kelp. W. Long. 6. 48. N. Lat. 56. 32.

TIROL, or TYROL, a county of Germany in the circle of Austria, under which may be included the territories belonging to the bishops of Brixen, Trent, and Chur, the Teutonic Order, and the prince of Deitrichstein, the Austrian seigniories before the Arlberg, and the Austrian districts in Swabia. It is 150 miles in length, and 120 in breadth, and contains 28 large towns.

The face of the country is very mountainous. Of these mountains some have their tops always buried in snow; others are covered with woods abounding with game. Of the lower, some yield plenty of corn, others wine, and woods of chesnut trees. The valleys are exceeding fertile also, and pleasant. In some places considerable quantities of flax are raised, in others there is a good breed of horses and horned cattle; and, among the mountains, abundance of chamois and wild goats. In this country are also found garnets, rubies, amethysts, agates, carnelians, calcedonies, malachites, &c.; nor is it without hot baths, acid waters, salt pits, mines of silver, copper, and lead. The principal river of Tirol is the Inn, which, after traversing the country, and receiving a number of lesser streams into it, enters Bavaria, in which, at Passau, it falls into the Danube. The men here are very tall, robust, and vigorous; the women also are stout, and generally fair; and both sexes have a mixture of the Italian and German in their tempers and characters. As there is little trade or manufacture in the country, except what is occasioned by the mines and salt works, many of the common people are obliged to seek a subsistence elsewhere. A particular kind of salutation is used all over Tirol. When a person comes into a house, he says, "Hail! Jesus Christ:" the answer is, "May Christ be raised, and the Holy Virgin his mother." Then the master of the house takes the visitor by the hand. This salutation is fixed up in print at all the doors, with an advertisement tacked to it, importing that Pope Clement XI. granted 100 days indulgence, and a plenary absolution, to those who should pronounce the salutation and answer, as often as they did it. The emperor has forts and citadels so advantageously situated on rocks and mountains all over the country, that they command all the valleys, avenues, and passes that lead unto it. The inhabitants, however, to keep them in good humour, are more gently treated, and not so highly taxed as those of the other hereditary countries. As to the states, they are much the same in this country as in the other Austrian territories, except that the peasants here send deputies to the diets. Tirol came to the house of Austria in the year 1363, when Margaret, countess thereof, bequeathed it to her uncles the dukes of Austria. Besides the governor, here are three sovereign colleges, subordinate to the court at Vienna, which sit at Inspruck, and have their different departments. Towards the expences of the military establishment of this country, the proportion is 100,000 florins yearly; but no more than one regiment of foot is generally quartered in it.

Tirol, Titan.

Tirol is divided into six quarters, as they are called; namely, those of the Lower and Upper Innthal, Vintsgow, Etch, Eisack, and Pusterthal. At the peace of Presburg in 1805, Austria was compelled to cede the Tirol. The brave inhabitants however took arms, and under Andrew Hofer an innkeeper, made an obstinate resistance. Deputies came to London to seek pecuniary supplies, and considerable sums were raised. But the French at last succeeded in subduing the country. The greater part of the Tirol was annexed to Bavaria, in whose possession it continued till 1815, when it was restored to Austria. Its population in 1815 amounted to 802,000 including Trent and Brixen.

TITAN, in fabulous history, the son of Cœlus and Terra, and the elder brother of Saturn, suffered the latter to enjoy the crown, on condition that he should bring up none of his male issue, by which means the crown should at length revert to him; but Jupiter being spared by the address of Rhea, Saturn's wife, Titan and his children were so enraged at seeing their hopes frustrated, that they took up arms to revenge the injury; and not only defeated Saturn, but kept him and his wife prisoners till he was delivered by Jupiter, who defeated the Titans; when from the blood of these Titans slain in the battle, proceeded serpents, scorpions, and all venomous reptiles. See SATURN.

Such is the account given by the poets of this family of Grecian and Roman gods. From the fragments of Sanchoniatho, however, and other ancient writers, many learned men have inferred that the Titans were an early race of ambitious heroes, who laid the foundation of that idolatry which quickly overspread the world, and that

Titan. that by assuming the names of the luminaries of heaven they contrived to get themselves every where adored as the *Dii majorum gentium*. That the word *Titan* signifies the sun, there can indeed be very little doubt. Every one knows that such was its signification in the Æolic dialect; and as it is evidently compounded of *Ti*, which, in some oriental tongues, signifies *bright* or *clear*, and *Tan*, which signifies a *country* or the *earth*, it may be safely concluded that *Titan* was the name of the sun before the word was imported into Greece. But the great question among antiquarians is, of what country was that race which, assuming to themselves the names of the heavenly bodies, introduced into the world that species of idolatry which is known by the appellation of *Hero-worship*?

M. Pezron, in a work published many years ago, and entitled *The Antiquities of Nations*, maintains that the Titans were a family of Sacæ or Scythians, who made their first appearance beyond Media and Mount Imaus, in the upper regions of Asia; that they were the descendants of Gomer the son of Japheth and grandson of Noah; and that after conquering a great part of the world, upon entering Upper Phrygia, they quitted their ancient name of Gomerians or Cimmerians, and assumed that of Titans. All this, he says, happened before the birth of Abraham and the foundation of the Assyrian monarchy; and he makes Uranus, their second prince in the order of succession, to have conquered Thrace, Greece, the island of Crete, and a great part of Europe. Uranus was succeeded by Saturn, and Saturn by Jupiter, who flourished, he says, 300 years before Moses, and divided his vast empire between himself, his brother Pluto, and his cousin-german Atlas, who was called *Telamon*. For the truth of this genealogy of the Titans M. Pezron appeals to the most approved Greek historians; but unluckily for his hypothesis, these writers have not a single sentence by which it can be fairly supported. It supposes not only the great antiquity of the Scythians, but likewise their early progress in arts and sciences, contrary to what we have proved in other articles of this work. See SCULPTURE, N° 4 and 5. and SCYTHIA.

Others, taking the fragment of Sanchoniatho's Phenician history for their guide, have supposed the Titans to have been the descendants of Ham. Of this opinion was Bishop Cumberland; and our learned friend Dr Doig, to whom we have been indebted for greater favours, indulged us with the perusal of a manuscript, in which, with erudition and ingenuity struggling for the pre-eminence, he traces that impious family from the profane son of Noah, and shows by what means they spread the idolatrous worship of themselves over the greater part of the ancient world. Cronus, of whose exploits some account has been given elsewhere (see SANCHONIATHO), he holds to be Ham; and tracing the progress of the family from Phœnicia to Cyprus, from Cyprus to Rhodes, thence to Crete, and from Crete to Samothrace, he finds reason to conclude that the branch called *Titans* or *Titanides* flourished about the era of Abraham, with whom, or with his son Isaac, he thinks the Cretan Jupiter must have been contemporary. As they proceeded from countries which were the original seat of civilization to others in which mankind had sunk into the grossest barbarism, it was easy for them to persuade the ignorant inhabitants that they derived the arts of civil life from their parent the sun, and in consequence of their relation to him to assume to themselves divine honours. To ask how they came to think of such gross impiety, is a question as foolish as it would be to ask how Ham their ancestor became so wicked as to entail the curse of God upon himself and his posterity. The origin of evil is involved in difficulties; but leaving all inquiries into it to be prosecuted by the metaphysician and moralist, it is surely more probable that the worship of dead men originated among the descendants of Ham than among those of Shem and Japheth; and that the fragment of Sanchoniatho, when giving an account of the origin of the Titans, the undoubted authors of that worship, is more deserving of credit than the fabulous and comparatively late writers of Greece and Rome. Titan, Tithes.

TITHES, in ecclesiastical law, are defined to be the tenth part of the increase, yearly arising and renewing from the profits of lands, the stock upon lands, and the personal industry of the inhabitants: the first species being usually called *predial*, as of corn, grass, hops and wood; the second *mixed*, as of wool, milk, pigs, &c. consisting of natural products, but nurtured and preserved in part by the care of man; and of these the tenth must be paid in gross; the third *personal*, as of manual occupations, trades, fisheries, and the like; and of these only the tenth-part of the clear gains and profits is due.

We shall, in this article, consider, 1. The original of the right of tithes. 2. In whom that right at present subsists. 3. Who may be discharged, either totally or in part, from paying them.

1. As to their original, we will not put the title of the clergy to tithes upon any divine right; though such a right certainly commenced, and we believe as certainly ceased, with the Jewish theocracy. Yet an honourable and competent maintenance for the ministers of the gospel is undoubtedly *jure divino*, whatever the particular mode of that maintenance may be. For, besides the positive precepts of the New Testament, natural reason will tell us, that an order of men who are separated from the world, and excluded from other lucrative professions for the sake of the rest of mankind, have a right to be furnished with the necessaries, conveniences, and moderate enjoyments of life, at their expence; for whose benefit they forego the usual means of providing them. Accordingly all municipal laws have provided a liberal and decent maintenance for their national priests or clergy; ours, in particular, have established this of tithes, probably in imitation of the Jewish law: and perhaps, considering the degenerate state of the world in general, it may be more beneficial to the English clergy to found their title on the law of the land, than upon any divine right whatsoever, unacknowledged and unsupported by temporal sanctions. *Blackst. Comment.*

We cannot precisely ascertain the time when tithes were first introduced into this country. Possibly they were contemporary with the planting of Christianity among the Saxons by Augustin the monk, about the end of the sixth century. But the first mention of them which we have met with in any written English law, is a constitutional decree, made in a synod held A. D. 786, wherein the payment of tithes in general is strongly enjoined. This canon or decree, which at first bound not the laity, was effectually confirmed by two kingdoms

Tithes. kingdoms of the heptarchy, in their parliamentary conventions of estates, respectively consisting of the kings of Mercia and Northumberland, the bishops, dukes, senators, and people. Which was a few years later than the time that Charlemagne established the payment of them in France, and made that famous division of them into four parts; one to maintain the edifice of the church, the second to support the poor, the third the bishop, and the fourth the parochial clergy.

The next authentic mention of them is in the *fœdus Edwardi et Guthruni*; or the laws agreed upon between King Guthrun the Dane, and Alfred and his son Edward the Elder, successive kings of England, about the year 900. This was a kind of treaty between those monarchs, which may be found at large in the Anglo-Saxon laws: wherein it was necessary, as Guthrun was a Pagan, to provide for the subsistence of the Christian clergy under his dominion; and accordingly, we find the payment of tithes not only enjoined, but a penalty added upon non-observance: which law is seconded by the laws of Athelstan, about the year 930. And this is as much as can certainly be traced out with regard to their legal original.

2. We are next to consider the persons to whom tithes are due. Upon their first introduction, though every man was obliged to pay tithes in general, yet he might give them to what priests he pleased; which were called *arbitrary consecrations of tithes*; or he might pay them into the hands of the bishop, who distributed among his diocesan clergy the revenues of the church, which were then in common. But when dioceses were divided into parishes, the tithes of each parish were allotted to its own particular minister; first by common consent or the appointments of lords of manors, and afterwards by the written law of the land.

Arbitrary consecrations of tithes took place again afterwards, and were in general use till the time of King John. This was probably owing to the intrigues of the regular clergy, or monks of the Benedictine and other orders, under Archbishop Dunstan and his successors; who endeavoured to wean the people from paying their dues to the secular or parochial clergy (a much more valuable set of men than themselves), and were then in hopes to have drawn, by sanctimonious pretences to extraordinary purity of life, all ecclesiastical profits to the coffers of their own societies. And this will naturally enough account for the number and riches of the monasteries and religious houses which were founded in those days, and which were frequently endowed with tithes. For a layman, who was obliged to pay his tithes somewhere, might think it good policy to erect an abbey, and there pay them to his own monks, or grant them to some abbey already erected; since for this donation, which really cost the patron little or nothing, he might, according to the superstition of the times, have masses for ever sung for his soul. But in process of years, the income of the poor laborious parish-priests being scandalously reduced by these arbitrary consecrations of tithes, it was remedied by Pope Innocent III. about the year 1200, in a decretal epistle sent to the archbishop of Canterbury, and dated from the palace of Lateran: which has occasioned Sir Henry Hobart and others to mistake it for a decree of the council of Lateran, held A. D. 1179, which only prohibited what was called the *infeodation of tithes*, or their being granted to mere laymen; whereas this letter of Pope Innocent to the archbishop enjoined the payment of tithes to the parsons of the respective parishes where every man inhabited, agreeable to what was afterwards directed by the same pope in other countries. This epistle, says Sir Edward Coke, bound not the lay subjects of this realm; but being reasonable and just, it was allowed of, and so became *lex terræ*. This put an effectual stop to all the arbitrary consecrations of tithes; except some footsteps which still continue in those portion of tithes which the parson of one parish hath, though rarely, a right to claim in another: for it is now universally held, that tithes are due, of common right, to the parson of the parish, unless there be a special exemption. This parson of the parish, may be either the actual incumbent, or else the appropriator of the benefice; appropriations being a method of endowing monasteries, which seems to have been devised by the regular clergy, by way of substitution to arbitrary consecrations of tithes.

3. We observed that tithes are due of common right to the parson, unless by special exemption; let us therefore see, *thirdly*, who may be exempted from the payment of tithes, and how lands and their occupiers may be exempted or discharged from the payment of tithes, either in a part or totally; first, by a real composition; or, secondly, by custom or prescription.

First, A real composition is when an agreement is made between the owner of the lands and the parson or vicar, with the consent of the ordinary and the patron, that such lands shall for the future be discharged from payment of tithes, by reason of some land or other real recompense given to the parson in lieu and satisfaction thereof. This was permitted by law, because it was supposed that the clergy would be no losers by such composition; since the consent of the ordinary, whose duty it is to take care of the church in general, and of the patron, whose interest it is to protect that particular church, were both made necessary to render the composition effectual: and hence have arisen all such compositions as exist at this day by force of the common law. But experience showing that even this caution was ineffectual, and the possessions of the church being by this and other means every day diminished, the disabling statute 13 Eliz. c. 10. was made; which prevents among other spiritual persons, all parsons and vicars from making any conveyances of the estates of their churches, other than for three lives of 21 years. So that now, by virtue of this statute, no real composition made since the 13 Eliz. is good for any longer term than three lives or 21 years, though made by consent of the patron and ordinary: which has indeed effectually demolished this kind of traffic; such compositions being now rarely heard of, unless by authority of parliament.

Secondly, a discharge by custom or prescription, is where time out of mind such persons or such lands have been either partially or totally discharged from the payment of tithes. And this immemorial usage is binding upon all parties; as it is in its nature an evidence of universal consent and acquiescence, and with reason supposes a real composition to have been formerly made. This custom or prescription is either *de modo decimandi*, or *de non decimando*.

A *modus decimandi*, commonly called by the simple name of a *modus* only, is where there is by custom a particular

Tithes.

particular manner of tithing allowed, different from the general law of taking tithes in kind, which are the actual tenth-part of the annual increase. This is sometimes a pecuniary compensation, as twopence an acre for the tithe of land: sometimes it is a compensation in work and labour, as that the parson shall have only the twelfth cock of hay, and not the tenth, in consideration of the owner's making it for him: sometimes, in lieu of a large quantity of crude or imperfect tithe, the parson shall have a less quantity when arrived at greater maturity, as a couple of fowls in lieu of tithe-eggs, and the like. Any means, in short, whereby the general law of tithing is altered, and a new method of taking them is introduced, is called a *modus decimandi*, or special manner of tithing.

A prescription *de non decimando* is a claim to be entirely discharged of tithes, and to pay no compensation in lieu of them. Thus the king by his prerogative is discharged from all tithes. So a vicar shall pay no tithes to the rector, nor the rector to the vicar, for *ecclesia decimas non solvit ecclesiæ*. But these personal privileges (not arising from or being annexed to the land) are personally confined to both the king and the clergy; for their tenant or lessee shall pay tithes, though in their own occupation their lands are not generally tithable. And, generally speaking, it is an established rule, that in lay hands, *modus de non decimando non valet*. But spiritual persons or corporations, as monasteries, abbots, bishops, and the like, were always capable of having their lands totally discharged of tithes by various ways: as, 1. By real composition. 2. By the pope's bull of exemption. 3. By unity of possession; as when the rectory of a parish, and lands in the same parish, both belonged to a religious house, those lands were discharged of tithes by this unity of possession. 4. By prescription; having never been liable to tithes, by being always in spiritual hands. 5. By virtue of their order; as the Knights Templars, Cistercians, and others, whose lands were privileged by the pope with a discharge of tithes. Though, upon the dissolution of abbeys by Henry VIII. most of these exemptions from tithes would have fallen with them, and the lands become tithable again, had they not been supported and upheld by the statute 31 Henry VIII. c. 13. which enacts, that all persons who should come to the possession of the lands of any abbey then dissolved, should hold them free and discharged of tithes, in as large and ample a manner as the abbeys themselves formerly held them. And from this original have sprung all the lands which being in lay hands, do at present claim to be tithe-free: for if a man can show his lands to have been such abbey-lands, and also immemorially discharged of tithes by any of the means before mentioned, this is now a good prescription *de non decimando*. But he must show both these requisites: for abbey-lands, without a special ground of discharge, are not discharged of course; neither will any prescription *de non decimando* avail in total discharge of tithes, unless it relates to such abbey-lands.

It is universally acknowledged that the payment of tithes in kind is a great discouragement to agriculture. They are inconvenient and vexatious to the husbandman, and operate as an impolitic tax upon industry. The clergyman, too, frequently finds them troublesome and precarious; his expences in collecting are a considerable drawback from their value, and his just rights are with difficulty secured: he is too often obliged to submit to imposition, or is embroiled with his parishioners in disputes and litigations, no less irksome to his feelings than prejudicial to his interest, and tending to prevent those good effects which his precepts should produce. It is therefore of the utmost importance to parochial tranquillity, and even to religion, that some just and reasonable standard of composition could be fixed. Land has been proposed, but in the present state of the division of property this is impossible: and as money is continually changing in its value, it would also be a very improper standard, unless some plan could be formed by which the composition could be increased as the value of money diminishes. A plan of this kind has been published in the Transactions of the Society instituted at Bath, vol. iv. which those who are interested in this subject may consult for farther information.

Tithes ‖ Titian.

TITHING, (*Tithinga*, from the Sax. *Theothunge*, i. e. *Decuriam*), a number or company of ten men, with their families, knit together in a kind of society, and all bound to the king, for the peaceable behaviour of each other. Anciently no man was suffered to abide in England above forty days, unless he were enrolled in some tithing.—One of the principal inhabitants of the tithing was annually appointed to preside over the rest, being called the *tithing-man*, the head-borough, and in some countries the borseholder, or borough's ealder, being supposed the discreetest man in the borough, town, or tithing. The distribution of England into tithings and hundreds is owing to King Alfred. See BORSEHOLDER.

TITIANO VECELLI, or TITIAN, the most universal genius for painting of all the Lombard-school, the best colourist of all the moderns, and the most eminent for histories, portraits, and landscapes, was born at Cadore, in the province of Friuli, in the state of Venice, in 1477, or in 1480 according to Vasari and Sandrart. His parents sent him at ten years of age to one of his uncles at Venice, who finding that he had an inclination to painting, put him to the school of Giovanni Bellino.

Pilkington's Dictionary of Painters.

But as soon as Titian had seen the works of Giorgione, whose manner appeared to him abundantly more elegant, and less constrained than that of Bellino, he determined to quit the style to which he had so long been accustomed, and to pursue the other that recommended itself to him, by having more force, more relief, more nature, and more truth. Some authors affirm, that he placed himself as a disciple with Giorgione; yet others only say, that he cultivated an intimacy with him; but it is undoubtedly certain that he studied with that great master; that he learned his method of blending and uniting the colours; and practised his manner so effectually, that several of the paintings of Titian were taken for the performances of Giorgione; and then his success inspired that artist with an invincible jealousy of Titian, which broke off their connection for ever after.

The reputation of Titian rose continually; every new work contributed to extend his fame through all Europe; and he was considered as the principal ornament of the age in which he flourished. And yet, Sandrart observes that amidst all his applause and constant employment at Venice, his income and fortune were inconsiderable; and

and he was more remarkable for the extensiveness of his talents, than for the affluence of his circumstances. But when his merit was made known to the emperor Chas. V. that monarch knew how to set a just value on his superior abilities; he enriched him by repeated bounties, allowed him a considerable pension, conferred on him the honour of knighthood, and, what was still more, honoured him with his friendship. He painted the portrait of that benefactor several times; and it is recorded by Sandrart, that one day, while the emperor was sitting for his picture, a pencil happening to drop from the painter, he stooped, took it up, and returned it; obligingly answering to the modest apology of the artist (who blushed at the condescension of so great a monarch), that the merit of a Titian was worthy of the attendance of an emperor.

The excellence of Titian was not so remarkably apparent in the historical compositions which he painted as in his portraits and landscapes, which seem to be superior to all competition; and even to this day, many of them preserve their original beauty, being as much the admiration of the present age as they have deservedly been of the ages past.—It is observed of Titian by most writers, that in the different periods of his life he had four different manners; one resembling his first instructor Bellino, which was somewhat stiff; another, in imitation of Giorgione, more bold, and full of force; his third manner was the result of experience, knowledge, and judgment, beautifully natural, and finished with exquisite care, which manner was peculiarly his own; and in those pictures which he painted between the years of approaching old age and his death may be noticed his fourth manner. His portraits were very differently finished in his early, and in his latter time, according to the testimony of Sandrart. At first he laboured his pictures highly, and gave them a polished beauty and lustre, so as to produce their effect full as well when they were examined closely as when viewed at a distance; but afterwards, he so managed his penciling, that their greatest force and beauty appeared at a more remote view, and they pleased less when they were beheld more nearly. So that many of those artists who studied to imitate him, being misled by appearances which they did not sufficiently consider, have imagined that Titian executed his work with readiness and a masterly rapidity; and concluded that they should imitate his manner most effectually by a freedom of hand and a bold pencil: Whereas in reality, Titian took abundance of pains to work up his pictures to so high a degree of perfection; and the freedom that appears in the handling was entirely effected by a skilful combination of labour and judgment.

It cannot be truly affirmed, that Titian equalled the great masters of the Roman school in design; but he always took care to dispose his figures in such attitudes as showed the most beautiful parts of the body. His taste in designing men was not generally so correct or elegant as it appeared in his boys and female figures; but his colouring had all the look of real flesh, his figures breathe. He was not so bold as Giorgione, but in tenderness and delicacy he proved himself much superior to him and all other artists. The expression of the passions was not his excellence, though even in that respect many of his figures merited the justest commendation; but he always gave his figures an air of ease and dignity. His landscapes are universally allowed to be unequalled, whether we consider the forms of his trees, the grand ideas of nature which appear in his scenery, or his distances which agreeably delude and delight the eye of every observer; and they are executed with a light, tender, and mellow pencil. He learned from nature the harmony of colours, and his tints seem astonishing, not only for their force, but their sweetness; and in that respect his colouring is accounted the standard of excellence to all professors of the art.

It would prove almost an endless task to enumerate the variety of works executed by this illustrious artist, at Rome, Venice, Bologna, and Florence, as well as those which are to be seen in other cities of Italy, in England, Spain, Germany, and France; but there are two, which are mentioned as being truly admirable. One is, a Last Supper, preserved in the refectory at the Escurial in Spain, which is inimitably fine; the other is at Milan, representing Christ crowned with thorns. The principal figure in the latter has an attitude full of grace and dignity more than mortal, and the countenance shows a benevolence and humility, combined with dignity and pain, which no pencil but that of Titian could so feelingly have described. It is admirably coloured, and tenderly and delicately penciled; the heads are wonderfully beautiful, the composition excellent, and the whole has a charming effect by the chiaro-scuro.

He was of so happy a constitution, that he was never ill till the year 1576, when he died of the plague, at 99 years of age. His disciples were Paulo Veronese, Giacomo Tintoret, Giacomo de Porte Bassano, and his sons.

TITLARK. See ALAUDA, ORNITHOLOGY *Index*.

TITLE, an appellation of dignity or rank given to princes and persons of distinction.

Titles were not so common among the ancient Greeks or Romans as they are in modern times. Till the reign of Constantine the title of *Illustrious* was never given except to those who were distinguished in arms or letters: But at length it became hereditary in the families of princes, and every son of a prince was illustrious. The title of *Highness* was formerly given only to kings. The kings of England before the reign of Henry VIII. were addressed by the title of *your Grace*. That monarch first assumed the title of *Highness*, and afterwards that of *Majesty*. The title of majesty was first given him by Francis I. in their interview in 1520. Charles V. was the first king of Spain who assumed the same title.

Princes, nobles, and clergy, generally have one title derived from their territories and estates, and another derived from their rank or from some other remarkable circumstance. The pope is called the *Bishop of Rome*, and has the title of *Holiness*. A cardinal has his name generally from some church, and is saluted by the name of *Eminent*, or *most Eminent*. An archbishop, besides being named from his diocese, is called *his Grace* and *most Reverend*: a bishop is also distinguished by the name of his diocese, and has the title of *his Lordship* and *right Reverend*. Inferior clergymen are denominated *Reverend*.

The titles of crowned heads derived from their dominions it is unnecessary to mention. It will be sufficient to mention those by which they are addressed. To an emperor

emperor is given the title of *Imperial Majesty*; to kings, that of *Majesty*; to the princes of Great Britain, *Royal Highness*; to those of Spain, *Infant*; to electors, *Electoral Highness*; to the grand duke of Tuscany, *Most Serene Highness*; to the other princes of Italy and Germany, *Highness*; to the doge of Venice, *Most Serene Prince*; to the grand-master of Malta, *Eminence*; to nuncios and ambassadors of crowned heads, *Excellency*; to dukes, *Grace*; to marquises, earls, and barons, *Lordship*.

The emperor of China, among his titles, takes that of *Tien Su*, "Son of Heaven." The Orientals, it is observed, are exceedingly fond of titles; the simple governor of Schiras, for instance, after a pompous enumeration of qualities, lordships, &c. adds the titles of *Flower of Courtesy*, *Nutmeg of Consolation*, and *Rose of Delight*.

TITLE, in *Law*, denotes any right which a person has to the possession of a thing, or an authentic instrument whereby he can prove his right. See the articles RIGHT, PROPERTY, &c.

TITLE to the Crown in the British Constitution. See SUCCESSION.

TITMOUSE. See PARUS, ORNITHOLOGY *Index*.

TITULAR, denotes a person invested with a title, in virtue of which he holds an office or benefice, whether he performs the functions thereof or not.

TITUS VESPASIANUS, the Roman emperor, the son of Vespasian; of whom it is related, that not being able to recollect any remarkable good action he had done on a certain day, he exclaimed, "I have lost a day!" He might truly be called the *father of his people*; and though Rome laboured under various public calamities during his reign, such was his equitable and mild administration, that he constantly preserved his popularity. He was a great lover of learning, and composed several poems. He reigned but two years; and it is thought Domitian his brother poisoned him, A. D. 81. aged 41. See (*History of*) ROME.

TIVIOT HILLS. See CHEVIOT.

TIVOLI, the modern name of TIBUR.

TOAD. See RANA, ERPETOLOGY *Index*.

TOAD-Fish. See LOPHIUS, ICHTHYOLOGY *Index*.

TOAD-Flax. See ANTIRRHINUM, BOTANY *Index*.

TOAD-Stone, an argillaceous stone. See GEOLOGY.

TOBACCO. See NICOTIANA, BOTANY *Index*, and SNUFF.

TOBACCO-Pipe-Fish. See FISTULARIA, ICHTHYOLOGY *Index*.

TOBACCO-Pipes, *Manufacture of*. The art of making tobacco-pipes, or, as it is commonly called, *pipe-making*, though one of the simplest species of pottery, is sufficiently curious to merit description in a dictionary of arts and sciences.

The process of pipe-making may be divided into six stages; viz. 1. Beating or preparing the clay; 2. Rolling; 3. Moulding; 4. Trimming; 5. Drying; and, 6. Burning.

Preparation of the Clay.—The fine white clay employed by the pipe-makers, is dug from the quarries in masses of about a cubic foot each. Before it can be used in the manufacture of tobacco-pipes, it must be reduced to the consistence of a tough paste. To effect this, after its outer surface has been cleared from dirt or dust, it is broken into small pieces about as large as a goose's egg, and thrown into a tub with such a quantity of soft water as experience has shown to be sufficient to bring it to the proper consistence. After lying till it has soaked up all the water, which usually requires from 12 to 24 hours, it is taken from the tub and laid on a thick strong wooden bench. Here it is beaten by a heavy four-square iron instrument, in such a manner as to cut it from one end to the other into very thin slices. It requires considerable address to perform this operation, and it is surprising how thin the workmen will sometimes cut the slices, and how equally they will thus divide the clay. This beating is continued, alternately folding up the clay and slicing it, till the whole is perfectly smooth. It is then ready for rolling.

Rolling.—The operation of rolling reduces the clay into pieces of a proper size and length for making pipes, and almost to the proper form. The roller sits at a bench with a smooth board before him, and holds in his hand another smooth board about 18 inches long, four broad, and about half an inch thick, having one end rounded off on one side, so as to produce a corresponding hollow in the clay. He now takes a piece of the beaten clay, and rolls it out, first with his hands, and then with the board, till it acquire the form of a long slender cylinder, with one end considerably larger than the rest. This large end is to form the bole, and the cylinder the shank of the future pipe. The pieces of clay thus formed are laid beside each other on a flat board, and are now ready for moulding.

Moulding.—This is the most complex operation, and requires the greatest number of instruments. The principal of these is the mould, which is composed of two long pieces of iron, formed so as to join together, and having their corresponding sides cut into the shape of half a tobacco pipe, each piece being hollowed so as to form half a slender cylinder, with a larger cavity at the upper end, and at such an angle as it is intended the bole of the pipe shall make with the shank. Just above that part of each side of the mould which stands beyond what is intended to form the bole, there is a notch for admitting a knife to cut off the superfluous clay. To receive the united mould there is a vice, having at one end two upright posts, between which moves a long lever, and to this lever, near the posts, there is loosely attached a piece of iron ending below in a smooth conical head, capable of entering the large opening of the mould, but rather smaller than the opening, so as that when forced down into it, a sufficient thickness of clay may be left between the cone and the sides of the mould, to form the bole of the pipe. One side of this vice is fixed, and the other moveable, towards the former. The moveable side has attached to it an iron screw with a very long lever as its handle, so that by turning the screw one way or the other, the moveable side of the vice may be forced nearer the fixed side, or suffered to return to its original position.

Besides these principal instruments, the moulder requires a slender steel wire, fixed in a handle at one end, and having its other extremity formed into a very small head; a saucer containing wool well impregnated with oil, and a small woollen or cotton brush.

When about to mould his pipes, he lays hold of the shank of one of the rolled pieces, and with great dexterity, which practice alone can teach, he passes up the oiled

Tobacco. oiled wire through its whole length, till he finds it arrived at the commencement of the larger extremity of the clay. This extremity he then bends to the proper angle, and having oiled the inside of each part of his mould, he lays the piece of clay with the wire in it, into one part of the mould, and covers it with the other. He now puts the mould containing the clay into the vice, and with the left hand turning round the handle of the screw, so as to fix the mould firmly within the vice, he, with the right hand, presses down the lever with its conical head, and thus forms the cavity of the bole. He now withdraws the mould, cuts off with his knife the superfluous clay from the bole, opens the mould, takes out the pipe, and now only withdraws the wire. He then lays the moulded pipe on a flat board, in the same manner as the rolled pieces before described. The pipes thus moulded require to be trimmed, that is, to have the prominences arising from the joining of the mould, and other superfluous pieces of clay taken off, so as to render the surface smooth and round.

Trimming.—The operation of trimming is generally performed by boys and girls, as it requires very little skill. The trimmer has before him a smooth block of wood, about the length of the pipe, and of considerable thickness, elevated a little at the remote end. He has also a thick piece of smooth iron, one edge of which has across it two or more semicylindrical grooves, capable of receiving half the shank of a pipe. Taking one of the rough moulded pipes, the trimmer carefully passes up the hollow of the shank, a wire similar to that employed in moulding, and holding the pipe by the bole, while the shank lies before him on the wooden block, he pares off with a blunt knife all the excrescences of clay, both from the shank and bole, and rubs the former, while lying on the block, with the grooved part of his iron, so as to render it as smooth as possible. He now cuts off the ragged piece at the extremity of the shank, withdraws the wire, and lays the pipe on the drying frame. One great object of the trimmer is, to see that the pipe is completely perforated, which he discovers by blowing through it; and if he finds the hole choked up, he must open it by pushing the wire as far as possible. If this does not succeed, he breaks the pipe as useless.

Drying.—The pipe has now received all the work that can be bestowed on it by the maker, previous to its being burned; but as the exposing of it to heat, while soft and pliable, would make it crack, it is necessary that it be properly dried. For this purpose, a frame is prepared, composed of three or four long pieces of wood, fastened to two end pieces in such a manner, as that the middle of the frame shall be the lowest, to give the shanks of the pipes that curve which they generally possess. After being trimmed, the pipes are laid beside each other in this concave frame, with their boles hanging down over the edges of the frame, and their shanks bending within its hollow. In this position they are exposed to the air till they are dry and firm. They are then ready for burning or baking.

Burning.—For burning or baking the pipes, there is to be prepared a kiln of a simple but peculiar construction. It is built in the form of a cylinder, close at the bottom and on the sides, and open at the top. Below the bottom is a grate for receiving the fuel, and round the sides are constructed vertical or spiral flues, opening at the top, and communicating below with the grate. The sides of the furnace on its interior are pretty thin, and are formed of a cement composed of clay mixed with fresh cow dung. In the middle of the cavity is placed a pedestal composed of the same materials, for the pipes to lean against. When the pipes are sufficiently dried, they are arranged round this pedestal, resting against it, and against each other, with their boles next the bottom of the furnace. They are thus placed in successive layers, till the furnace be sufficiently full, when the open space at top is filled up with bricks placed over each other, so as to leave interstices for the free circulation of the air, and of the smoke and flame which issue through the flues. In these interstices are laid several pieces of broken dried pipes, to serve as pyrometers for ascertaining the state of the included pipes during the burning. The fire is now lighted, and kept up, till, on examining the pieces of clay laid in the interstices of the bricks, it is concluded that the pipes within the furnace are sufficiently baked. The fire is then suffered to go out, and the whole to cool till the next day, when the bricks are taken down, the pipes removed, and packed in barrels for sale.

After being burnt, the pipes are sometimes glazed, which is done by rubbing them, while warm, with flannel and a little white flax. In some places the extremities of the shanks are rendered smooth by dipping them before burning in the ordinary potters glazing, which prevents that adhesion to the lips so unpleasant in new unglazed pipes.

Tobacco, Tobago. TOBAGO, one of the Caribbee islands, ceded to Great Britain by the treaty of Paris in 1763, taken by the French in 1781, and retaken by the British in 1793. It lies in the latitude of 11 degrees 10 minutes north, and 59 degrees 40 minutes longitude west from London, about 40 leagues south-by-west from Barbadoes, 35 south-east from St Vincents, 20 south-east from Grenada, 12 north-east from the Spanish island of Trinidada, and between 30 and 40 north-east from the Spanish main. According to the latest accounts, it is somewhat more than 30 miles in length from north-east to south-west, between 8 and 9 in breadth, and from 23 to 25 leagues in circumference. The English visited this island very early, Sir Robert Dudley being there in the reign of Queen Elizabeth. In that of Charles I. William earl of Pembroke procured a grant of this, with two other small islands; but died before he was able to carry into execution his design of settling them. In A. D. 1632 some merchants of Zealand sent over a small colony thither, and gave it the name of *New Walcheren;* but before they were able thoroughly to establish themselves, they were destroyed by the Indians assisted by the Spaniards. Ten years after, James duke of Courland sent a colony thither, who settled themselves upon Great Courland bay, and made a considerable progress in planting. A. D. 1654, Messieurs Adrian and Cornelius Lampsius, two opulent merchants of Flushing, sent a considerable number of people thither, who settled on the other side of the island, and lived in amity with the Courlanders, until they learned that the king of Sweden had seized the person of their duke and dispossessed him of his dominions, when they attacked and forced his subjects to submit. The duke being afterwards restored, he obtained from Charles II. a grant of this island, dated the 17th of November 1664.

1664. In the second Dutch war the count d'Estrees, by order of his master, totally ruined it at the close of the year 1677; and from that time it continued waste till Britain took possession of it after the treaty of Paris. The climate, notwithstanding its vicinity to the line, is so tempered by the breezes from the sea, as to be very supportable even to Europeans; and has the same advantages with that of Grenada, in having regular seasons, and also in being exempt from the hurricanes. There are throughout the island many rising grounds, though, except at the north-east extremity, there is no part of it that can be styled mountainous; and even there the country is far from being rugged or impassable. The soil, if we may credit either Dutch or French writers, is as fertile and luxuriant as any of the islands, and very finely diversified. Ground provisions of all sorts have been raised in great plenty, a vast variety of vegetables, excellent in their kind, some for food, some for physic. Almost every species of useful timber is to be found here, and some of an enormous size; amongst others, the true cinnamon and nutmeg tree, as the Dutch confess, and of which none could be better judges; whole groves of sassafras, and of trees that bear the true gum copal, with other odoriferous plants that render the air wholesome and pleasant. It is as well watered as can be wished, by rivers that fall into the sea on both sides, many smaller streams, and fine fresh springs in almost every part of the island. The sea-cost is indented by 10 or 12 fair and spacious bays, and there are amongst these one or two ports capable of receiving as large ships as ever visited those seas. There are wild hogs in great plenty, abundance of fowls of different kinds, and a vast variety of sea and river fish. At the north-east extremity lies little Tobago, which is two miles long, and about half a mile broad, very capable of improvement.

TOBOLSK, the capital of a province of the same name in Asiatic Russia, comprehending the greater part of the country known by the name of Siberia, is situated at the confluence of the rivers Tobol and Irtish, in N. Lat. 58° 12′, E. Long. 68° 18.′ The city stands upon the ascent of a high hill, the lower part of which is inhabited by Mahometan Tartars, who carry on a considerable traffic upon the river Irtish, and convey their merchandise quite across Great Tartary, as far as China. The river Irtish joins the Tobol, and both fall into the Oby. By means of these two rivers, there is a constant flow of merchandise into the city during the summer season. Tobolsk is therefore a great mart for the commodities of Muscovy, Tartary, and other countries: and here is a great concourse of merchants. All sorts of provisions are plentiful and cheap. An hundred weight of rice is sold for 16 copecs, equal to about eightpence sterling; a sturgeon weighing 40 pounds, for half that money; an ox for two rix-dollars, and every other article in proportion. The adjacent country abounds with game in great variety. The supreme court of judicature for all Siberia is held in this city, which is also the seat of a metropolitan, sent hither from Moscow to exercise spiritual jurisdiction over the whole kingdom. Tobolsk is well fortified, and defended by a strong garrison, under the command of the governor, who resides in the place, and takes charge of the fur tribute, which is here deposited in proper magazines. This governor enjoys a very extensive command, and can occasionally bring into the field 9000 men besides a strong body of Tartars on horseback, to make head against the Kalmucks and Cossacks, in their repeated incursions. A sufficient number of Russians, called *Jemskoiks*, are kept in continual pay by the government, on the banks of the Irtish, to supply travellers on the czar's account with men, boats, or carriages, to convey them as far as Surgut on the Oby, a voyage of 200 leagues by water. This is the common method of travelling in the summer; but in winter the journey by land is not half so long, being performed in sleds over the ice and snow, with which the country is covered. These sleds are moved by a pair of dogs, which will draw a load of 300 pounds with surprising expedition. They are hired at easy rates, and during one half of the year may be seen flying over the snow in great numbers. The city is supposed to contain 15,000 inhabitants. It is 900 miles east from Moscow, and 1200 from Petersburgh.

TODDA Panna. See Cycas, Botany *Index*.

TODDY, a name given to the juice of the cocoa-nut tree. See Arack.—Tody is also a name given to a mixture of spirits, water, and sugar.

Toddy-Bird. See Loxia, Ornithology *Index*.

TODUS, the Tody; a genus of birds belonging to the order of picæ. See Ornithology *Index*.

TOGA, in Roman antiquity, a wide woollen gown or mantle, which seems to have been of a semicircular form, without sleeves; differing both in richness and largeness, according to the circumstances of the wearer, and used only upon occasion of appearing in public.

Every body knows that the toga was the distinguished mark of a Roman: hence the *jus togæ*, or privilege of a Roman citizen; i. e. the right of wearing a Roman habit, and of taking as they explain it, fire and water through the Roman empire.

TOKAY wine, derives its name from a town of Hungary, where it is produced. There are four sorts of wine made from the same grapes, distinguished at Tokay by the names of *essence*, *auspruch*, *masluch*, and the *common wine*. The essence is made by picking out the half-dried and shrivelled grapes, and putting them into a perforated vessel, where they remain as long as any juice runs off by the mere pressure of their own weight. This is put into small casks. The auspruch is made by pouring the expressed juice of the grapes from which the former had been picked on those that yielded the essence, and treading them with the feet. The liquor thus obtained stands for a day or two to ferment, and then is poured into small casks, which are kept in the air for about a month, and afterwards put into casks. The same process is again repeated by the addition of more juice to the grapes which have already undergone the two former pressures, and they are now wrung with the hands; and thus is had the maslach. The fourth kind is made by taking all the kinds together at first, and submitting them to the greatest pressure: this is chiefly prepared by the peasants. The essence is thick, and very sweet and lucious: it is chiefly used to mix with the other kinds. The auspruch is the wine commonly exported, and which is known in foreign countries by the name of *Tokay*.

The goodness of it is determined by the following rules. The colour should neither be reddish nor very pale, but a light silver: in trying it, the palate and tip of

Tokay Wine ‖ Toledo.

of the tongue should be wetted without swallowing it, and if it manifest any acrimony to the tongue it is not good; but the taste ought to be soft and mild: when poured out, it should form globules in the glass, and have an oily appearance: when genuine, the strongest is always of the best quality: when swallowed, it should have an earthy astringent taste in the mouth, which is called the taste of the root. All tokay wine has an aromatic taste, which distinguishes it from every other species of wine. It keeps to any age, and improves by time: but is never good till about three years old. It is the best way to transport it in casks; for when it is on the seas, it ferments three times every season, and thus refines itself. When in bottles, there must be an empty space left between the wine and the cork, otherwise it would burst the bottle. A little oil is put upon the surface, and a piece of bladder tied over the cork. The bottles are always laid on their sides in sand. Phil. Trans. vol. lxiii. part ii. p. 292, &c.

TOKENS. See *Tradesmens Tokens*.

TOISE, or Fathom, a French measure containing six of their feet, equal to 6,3945 English feet.

TOLAND, John, a famous writer, was born near Londonderry in Ireland in 1670, and educated in the Popish religion; but at 16 years of age embraced the principles of the Protestants. He studied three years at the university of Glasgow; was created master of arts in the university of Edinburgh; and afterwards completed his studies at Leyden, where he resided two years. He then went to Oxford, where, having the advantage of the public library, he collected materials upon various subjects, and composed some pieces; among which was, A Dissertation to prove the received history of the tragical death of Atilius Regulus, the Roman consul, to be a fable. He began likewise a work of greater consequence, in which he undertook to show that there are no mysteries in the Christian religion. He published it in 1696 at London, under the title of *Christianity not mysterious*. This book gave great offence, and was attacked by several writers. He afterward wrote in favour of the Hanoverian succession, and many other pieces. In 1707 he went into Germany, where he visited several courts; and in 1710 he was introduced to Prince Eugene, who gave him several marks of his generosity. Upon his return to England he was for some time supported by the liberality of the earl of Oxford lord-treasurer, and kept a country house at Epsom; but soon losing his lordship's favour, he published several pamphlets against that minister's measures. In the last four years of his life he lived at Putney, but used to spend most part of the winter in London. Mr Toland died at London in 1722. He was a man of uncommon abilities, published a number of curious tracts, and was perhaps the most learned of all the infidel writers; but his private character was far from being an amiable one; for he was extremely vain, and wanted those social virtues which are the chief ornaments as well as duties of life. His posthumous works, two volumes octavo, were published in 1726, with an account of his life and writings, by Mr Des Maizeaux.

TOLEDO, an ancient and trading city of Spain in New Castile, of which it was formerly the capital. About two centuries ago it is said to have contained more than 200,000 inhabitants; but they are now diminished to 20,000, or at most to 30,000. It is advantageously seated on the river Tajo, which surrounds it on two sides; and on the land side, it has an ancient wall built by a Gothic king, and flanked with 100 towers. It is seated on a mountain, which renders the streets uneven, and which are narrow; but the houses are fine, and there are a great number of superb structures, besides 17 public squares, where the markets are kept. The finest buildings are the royal castle and the cathedral church; which last is the richest and most considerable in Spain. It is seated in the middle of the city, joining to a handsome street, with a fine square before it. Several of the gates are very large, and of bronze. There is also a superb steeple, extremely high, from whence there is a very distant prospect. The Sagrariro, or principal chapel, is a real treasury, in which are 15 large cabinets let into the wall, full of prodigious quantities of gold and silver vessels, and other works. There are two mitres of silver gilt, set all over with pearls and precious stones, with three collars of massy gold, enriched in like manner. There are two bracelets and an imperial crown of the Virgin Mary, consisting of large diamonds and other jewels. The weight of the gold in the crown is 15 pounds. The vessel which contains the consecrated wafer is of silver gilt, as high as a man, and so heavy, that it requires 30 men to carry it; within it is another of pure gold enriched with jewels. Here are 39 religious houses, most of which are worthy a traveller's notice, with many other sacred buildings, besides seventy churches belonging to 27 parishes, and fifteen hospitals. Without the town are the remains of an amphitheatre, and other antiquities.

Bourgoanne's Travels in Spain, vol. ii.

Toledo ‖ Toleration.

Toledo is an archbishop's see, who is primate of Spain, and perhaps the richest prelate in Europe. His revenue is said to amount to 125,000l. sterling, but there are large deductions to be made from it. He pays 15,000 ducats to the monks of the Escurial, besides several other pensions. Toledo has also a university. It was formerly celebrated for the exquisite temper of the sword blades made there. It is situated in E. Long. 3. 15. N. Lat. 39. 50. and is 37 miles south from Madrid.

Swinburne and Laborde's Travels in Spain.

TOLERATION, in matters of religion, is either civil or ecclesiastical. Civil toleration is an impunity and safety granted by the state to every sect that does not maintain doctrines inconsistent with the public peace: and ecclesiastical toleration is the allowance which the church grants to its members to differ in certain opinions, not reputed fundamental.

As the gods of Paganism were almost all local and tutelary, and as it was a maxim universally received that it was the duty of every man to worship, together with his own deities, the tutelary gods of the country in which he might chance to reside, there was no room for persecution in the Heathen world, on account of different sentiments in religion, or of the different rites with which the various deities were worshipped. Had the primitive Christians joined their fellow-citizens in the worship of Jupiter, Juno, and the rest of the rabble of Roman divinities, they would have been suffered to worship, without molestation, the Creator of the world and the Redeemer of mankind; for in that case the God of the Christians would have been looked upon as a Being of the same kind with the gods of the empire; and the great principle of intercommunity would have remained unviolated. But the true God had expressly prohibited

Toleration. prohibited both Jews and Christians from worshipping any other god besides Himself; and it was their refusal to break that precept of their religion which made their Heathen masters look upon them as Atheists, and persecute them as a people inimical to the state. Utility, and not truth, was the object for which the Heathen legislatures supported the national religion. They well knew that the stories told by their poets of their different divinities, of the rewards of Elysium, and of the punishments of Tartarus, were a collection of senseless fables; but they had nothing better to propose to the vulgar, and they were not such strangers to the human heart, as to suppose that mankind could live together in society without being influenced in their conduct by some religion.

Widely different from the genius of Paganism was the spirit of the Jewish dispensation. Truth, which is in fact always coincident with general utility, was the great object of the Mosaic law. The children of Israel were separated from the rest of the world, to preserve the knowledge and worship of the true God, at a time when all the other nations on earth, forgetting the Lord that made them, were falling prostrate to stocks and stones, and worshipping devils and impure spirits. Such was the contagion of idolatry, and so strong the propensity of the Israelites to the customs and manners of the Egyptians, and other polytheistic nations around them, that the purpose of their separation could not have been served, had not Jehovah condescended to become not only their tutelary God, but even their supreme civil Magistrate (see THEOLOGY, N° 151.); so that under the Mosaic economy, idolatry was the crime of high treason, and as such justly punished by the laws of the state. Among the Jews, the church and state were not indeed different societies. They were so thoroughly incorporated, that what was a sin in the one was a crime in the other; and the forfeiture of ecclesiastical privileges was the forfeiture of the rights of citizens.

In many respects the Christian religion is directly opposite to the ritual law of Moses. It is calculated for all nations, and intended to be propagated among all. Instead of separating one people from another, one of its principal objects is to disseminate universal benevolence, and to inculcate upon the whole human race, that mutual love which naturally springs from the knowledge that all men are brethren. Its ultimate end being to train its votaries for heaven, it concerns itself no farther with the affairs of earth than to enforce by eternal sanctions the laws of morality; and the kingdom of its Founder not being of this world, it leaves every nation at liberty to fabricate its own municipal laws, so as best to serve its own interest in the various circumstances in which it may be placed; and denounces a curse upon all who pay not to those laws the fullest obedience, when they are not obviously inconsistent with the laws of piety and virtue, which are of prior obligation. The Christian church therefore must always remain a distinct society from the state; and though, till the present age of hazardous innovations, it has been deemed expedient in every country, where the truth of the gospel is admitted, to give to the religion of Christ a legal establishment, and to confer immunities on its ministers, this measure has been adopted, not to secure the purity of the faith, which appeals to the private judgment of each individual, but merely to preserve the peace of society, and to put a restraint upon those actions of which human laws cannot take cognizance. With religion, Christian governments have no farther concern than as it tends to promote the practice of virtue. The early Christians, however, not understanding the principle upon which penal laws were employed to preserve the purity of the Jewish religion; and, as our blessed Lord observed to two of his apostles, not knowing what spirit they were of—hastily concluded that they had a right to enforce the doctrines and worship of the New Testament, by the same means which had been used to preserve the Israelites steady to the doctrines and worship of the Old. Hence, though they had suffered the cruellest persecutions themselves (see PERSECUTION), they no sooner got the power of the state in their hands, than they persecuted the Pagans for their idolatry; and afterwards, when heresies arose in the church, persecuted one another for expressing in different phrases metaphysical propositions, of such a nature as no human mind can fully comprehend. The apostle had forewarned them that there must be heresies in the church, that they who are approved may be made manifest; but it did not occur to them that persecution for opinion is the worst of all heresies, as it violates at once truth and charity.

Hitherto these unhallowed means of bringing Christians to uniformity of faith and practice, had been only occasionally employed, from their not accurately distinguishing between the spirit of the gospel and that of the law; but as soon as the bishops of Rome had brought the inhabitants of Europe to recognize their infallibility in explaining articles of faith and deciding points of controversy, persecution became a regular and permanent instrument of ecclesiastical discipline. To doubt or to deny any doctrine to which these unerring instructors had given the sanction of their approbation, was held to be not only a resisting of the truth, but an act of rebellion against their sacred authority; and the secular power, of which, by various arts, they had acquired the absolute direction, was instantly employed to avenge both.

Robertson's History of Charles V.

"Thus Europe had been accustomed, during many centuries, to see speculative opinions propagated or defended by force; the charity and mutual forbearance, which Christianity recommends with so much warmth, were forgotten; the sacred rights of conscience and of private judgment were unheard of; and not only the idea of toleration, but even the word itself, in the sense now affixed to it, was unknown. A right to extirpate error by force, was universally allowed to be the prerogative of those who possessed the knowledge of truth; and though the first reformers did not arrogate to themselves in direct terms that infallibility which they had refused to the church of Rome, they were not less confident of the truth of their own doctrines, and required with equal ardour the princes of their party to check such as presumed to impugn or to oppose them. To this request too many of these princes lent a willing ear. It flattered at once their piety and their pride, to be considered as possessing all the rights of Jewish princes; and Henry the VIII. of England, after labouring to make his divines declare that all authority ecclesiastical as well as civil flows from the crown, persecuted alternately the Papists and Protestants. Many of his successors, whose characters were much better than his, thought themselves duly authorized

authorized, in virtue of their acknowledged supremacy over all states and conditions of men, to enforce by means of penal laws a uniformity of faith and worship among their subjects: and it was not till the revolution that any sect in England seems to have fully understood, that all men have an unalienable right to worship God in the manner which to them may seem most suitable to his nature, and the relation in which they stand to him; or that it is impossible to produce uniformity of opinion by any other means than candid disquisition and sound reasoning. That the civil magistrate has a right to check the propagation of opinions which tend only to sap the foundations of virtue, and to disturb the peace of society, cannot, we think, be questioned; but that he has no right to restrain mankind from publicly professing any system of faith, which comprehends the being and providence of God, the great laws of morality, and a future state of rewards and punishments, is as evident as that it is the object of religion to fit mankind for heaven, and the whole duty of the magistrates to maintain peace, liberty, and property, upon earth. We have elsewhere observed (see TEST), that among a number of different sects of Christians, it is not the superior purity of the system of faith professed by one of them, that gives it a right to the immunities of an establishment in preference to all its rivals; but though the legislature is authorized, in certain circumstances, to make a less pure system the religion of the state, it would be the height of absurdity to suppose that any man, or body of men, can have authority to prevent a purer system from being acknowledged as the religion of individuals. For propagating opinions and pursuing practices which necessarily create civil disturbance, every man is answerable to the laws of his country; but for the soundness of his faith, and the purity of his worship, he is answerable to no tribunal but that which can search the heart.

When churches are established, and creeds drawn up as guides to the preaching of the national clergy, it is obvious that every clergyman who teaches any thing directly contrary to the doctrine of such creeds, violates the condition on which he holds his living, and may be justly deprived of that living, whether his obnoxious opinion be in itself true or false, important or unimportant; but his punishment should be extended no farther. To expel a Christian from private communion for teaching any doctrine which is neither injurious to the state nor contrary to the few simple articles which comprise the sum of the Christian faith, is the grossest tyranny; and the governors of that church which is guilty of it, usurp the prerogative of the blessed Lord, who commanded the apostles themselves not to be called masters in this sense; for one (says he) is your master (υμων ὁ καθηγητης), even Christ. It is indeed a hardship to deprive a man of his living for conscientiously illustrating what he believes to be a truth of the gospel, only because his illustration may be different from that which had formerly been given by men fallible like himself; but if the establishment of human compilations of faith be necessary, this hardship cannot be removed, but by making such compilations as simple as possible, and drawing them up in scripture language. Such a reformation, could it be effected peaceably, would serve other good purposes; for while it would sufficiently guard the purity of the faith, it would withdraw that temptation which too many establishments throw in the way of men, to subscribe to the truth of what they do not really believe; and it would effectually banish from the Christian church every thing which can be called by the name of *persecution*. See NONCONFORMISTS.

TOLL, a tax or custom paid for liberty to vend goods in a market or fair, or for keeping roads in proper repair. The first appointment of a toll on highways of which we read, took place in 1346. See ROAD.

TOLOUSE. See TOULOUSE.

TOLU, a town of South America in Terra Firma, and in the government of Carthagena; famous for the fine balsam of Tolu, brought into Europe from thence, and produced from a tree like a pine. It is seated on a bay of the Carribbean sea, 60 miles south of Carthagena. W. Long. 75. 25. N. Lat. 9. 45.

TOLUIFERA, the BALSAM-of-TOLU TREE; a genus of plants belonging to the class of decandria. See BOTANY, p. 182. and CHEMISTRY, N° 2483.

TOMATOES. See SOLANUM, BOTANY *Index*.

TOMB, includes both the grave or sepulchre wherein a defunct is interred, and the monument erected to preserve his memory. The word is formed from the Greek τυμβος, *tumulus*, "sepulchre;" or, according to Menage, from the Latin *tumba*, which signifies the same.

In many nations it has been customary to burn the bodies of the dead, and to collect the ashes with pious care into an urn, which was deposited in a tomb or sepulchre. See BURNING. Among many nations it has also been the practice to lay the dead body in a tomb, without consuming it, after having wrapped it up decently, and sometimes placing it in a coffin. See COFFIN.

The tombs of the Jews were generally hollow places hewn out of a rock. Abraham buried Sarah in a cave. Such was the place too in which the kings of Judah and Israel were interred: and such was the place in which the body of our Saviour was deposited by Joseph of Arimathea. But it is probable that the common people buried their dead in graves; for our Saviour compares the Pharisees to "graves which appear not, and the men that walk over them are not aware of them." Over the tombs, perhaps only of people of distinction, a stone or monument was erected, to intimate to passengers that they were burying places, that they might not pollute themselves by touching them. With the same intention, as Lightfoot informs us, they whitened them every year on the 15th of February.

The Egyptians also buried their dead in caves, called *catacombs*. See CATACOMB. The pyramids, as some think, were also employed for the same purpose. Sometimes also, after embalming their dead, they placed them in niches in some magnificent apartment in their houses.

The Greeks and Romans burned their dead, and deposited their ashes in a tomb. The Greeks interred the ashes without the cities, by the sides of their highways. Sometimes indeed, by way of particular honour, they were buried in an elevated part of the town; and the Lacedæmonians were allowed by Lycurgus to bury in the city and round their temples: But this was forbidden among the Romans by the law of the twelve tables, *In urbe ne sepelito, neve urito;* yet Valerius Publicola, Posthumus Tubertius, and the family of the Claudii, were buried in the Capitol. To bury by the sides of public

Tomb. public roads was common among the Romans also; hence their epitaphs frequently began with *Siste viator*. Highways were made choice of probably for two reasons: 1. That the dead might not be offensive or injure the health of the living, which they certainly would if buried in towns or populous places; and, 2dly, That they might hold out to travellers a lesson of mortality, and teach the rustic moralist to die.

As it would swell this article to too great a size, to describe all the different kinds of tombs which have been used by different nations and ages, we must content ourselves with shortly describing the tombs of a few nations, and adding a few concomitant circumstances.

The tombs of the Parsees are singular. The deceased, after lying a proper time in his own house, for the purposes of mourning, is carried, followed by his relations and friends, the females chanting a requiem, and deposited in a tomb of the following construction: It is a circular building, open at top, about 55 feet diameter, and 25 feet in height, filled to within 5 feet of the top, excepting a well of 15 feet diameter in the centre. The part so filled is terraced, with a slight declivity toward the well. Two circular grooves three inches deep are raised round the well; the first at the distance of four, the second at ten, feet from the well. Grooves of the like depth or height, and four feet distance from each other at the outer part of the outer circle, are carried straight from the wall to the well, communicating with the circular ones, for the purpose of carrying off the water, &c. The tomb, by this means, is divided into three circles of partitions: the outer, about seven feet by four: the middle six by three: the inner, four by two: the outer for the men, the middle for the women, the inner for the children; in which the bodies are respectively placed, wrapped loosely in a piece of cloth, and left to be devoured by the vultures; which is very soon done, as numbers of those animals are always seen hovering and watching about these charnel houses, in expectation of their prey. The friends of the deceased, or the persons who have charge of the tomb, come, at the proper time, and throw the bones into their receptacle, the well in the centre; for which purpose, iron rakes and tongs are deposited in the tomb. The entrance is closed by an iron door, four feet square, on the eastern side, as high up as the terrace, to which a road is raised. Upon the wall, above the door, an additional wall is raised, to prevent people from looking into the tomb, which the Parsees are particularly careful to prevent. A Persian inscription is on a stone inserted over the door, which we once copied, but have forgotten its tenor. From the bottom of the wall subterraneous passages lead to receive the bones, &c. and prevent the well from filling.

Of the ancient sepulchres found in Russia and Siberia, some are perfect tumuli, raised to an enormous height, while others are almost level with the ground. Some of them are encompassed with a square wall of large quarry stones placed in an erect position; others are covered only with a small heap of stones, or they are tumuli adorned with stones at top. Some are walled with brick within, and vaulted over; others are no more than pits or common graves. In some the earth is excavated several fathoms deep; others, and especially those which are topped by a lofty tumulus, are only dug of a sufficient depth for covering the carcase. In many of these sepulchres the bones of men, and frequently of horses, are found, and in a condition that renders it probable the bodies were not burnt before they were inhumed. Other bones show clearly that they have been previously burnt; because a part of them is unconsumed, and because they lie in a disordered manner, and some of them are wanting. Urns, in which other nations of antiquity have deposited the ashes of their dead, are never met with here. But sometimes what remained of their bodies after the combustion, and even whole carcases, are found wrapped up in thin plates of gold. Many dead bodies are frequently seen deposited together in one tomb; a certain indication that either a battle had been fought in the neighbourhood of the place, or that some families buried their relations in an hereditary tomb.

Archæologia, vol. vii.

The Moors, like all other Mahometans, hold it contrary to the spirit of religion to bury their dead in mosques, and to profane the temple of the Most High by the putrefaction of dead bodies. In the infancy of the church the Christians had the like respect for their temples. The burial grounds of the Mahometans are without the city; the emperors have their sepulchres distinct and distant from the mosque, in sanctuaries, built by themselves: their tombs are exceedingly simple.

Chenier's Morocco, vol. i.

All Mahometans inter the dead at the hour set apart for prayer. The defunct is not kept in the house, except he expires after sunset; but the body is transported to the mosque, whither it is carried by those who are going to prayer. Each, from a spirit of devotion, is desirous to carry in his turn. The Moors sing at their burial service; which usage perhaps they have imitated after the Christians of Spain. They have no particular colour appropriated to mourning. Women regularly go on the Friday to weep over and pray at the sepulchres of the dead, whose memory they hold dear.

Among the northern nations it was customary to bury their dead under heaps of stones called *cairns*, or under barrows: (See the articles CAIRNS and BARROW.) The inhabitants of Tibet, it is said, neither bury nor burn their dead; but expose them on the tops of mountains. See TIBET.

Tomb ‖ Tone.

TOMBUCTOO, a city of Africa, and capital of a rich and populous country, situated near the Niger, in E. Long. 1. 30. and N. Lat. 16. 30. Some manufactures, particularly that of cotton cloth, are carried on in Tombuctoo; and it has a considerable trade with the caravans. Many fruitless attempts have recently been made by European travellers to reach this city, which is supposed to be one of the most considerable in the interior of Africa. See AFFRICA, SUPPLEMENT.

TOMPION, a sort of bung or cork used to stop the mouth of a cannon. At sea this is carefully encircled with tallow or putty, to prevent the penetration of the water into the bore, whereby the powder contained in the chamber might be damaged or rendered incapable of service.

TON, a measure or weight. See TUN.

TONE, or TUNE, in *Music*, a property of sound, whereby it comes under the relation of *grave* and *acute*; or

Tone ‖ Tonnage.

or the degree of elevation any sound has, from the degree of swiftness of the vibrations of the parts of the sonorous body.

The variety of tones in human voices arises partly from the dimensions of the windpipe, which, like a flute, the longer and narrower it is, the sharper the tone it gives; but principally from the head of the larynx or knot of the throat: the tone of the voice being more or less grave as the rima or cleft thereof is more or less open.

The word *tone* is taken in four different senses among the ancients: 1. For any sound; 2. For a certain interval, as when it is said the difference between the diapente and diatessaron is a tone; 3. For a certain locus or compass of the voice, in which sense they used the Dorian, Phrygian, Lydian tones; 4. For tension, as when they speak of an acute, grave, or a middle tone.

TONE is more particularly used, in music, for a certain degree or interval of tune, whereby a sound may be either raised or lowered from one extreme of a concord to the other, so as still to produce true melody.

TONGUE. See ANATOMY, N° 102.

TONIC, in *Music*, signifies a certain degree of tension, or the sound produced by a vocal string in a given degree of tension, or by any sonorous body when put in vibration.

Tonic, says Rousseau, is likewise the name given by Aristoxenus to one of the three kinds of chromatic music, whose divisions he explains, and which was the ordinary chromatic of the Greeks, proceeding by two semitones in succession, and afterwards a third minor.

TONIC Dominant. See DOMINANT.

TONNAGE *and* POUNDAGE, an ancient duty on wine and other goods, the origin of which seems to have been this: About the 21st of Edward III. complaint was made that merchants were robbed and murdered on the seas. The king thereupon, with the consent of the peers, levied a duty of 2s. on every ton of wine, and 12d. in the pound on all goods imported; which was treated as illegal by the commons. About 25 years after, the king, when the knights of shires were returned home, obtained a like grant from the citizens and burgesses, and the year after it was regularly granted in parliament. These duties were diminished sometimes, and sometimes increased; at length they seem to have been fixed at 3s. tonnage and 1s. poundage. They were at first usually granted only for a stated term of years, as, for two years in 5 Ric. II.; but in Henry VI.'s time they were granted him for life by a statute in the 31st year of his reign; and again to Edward IV. for the term of his life also: since which time they were regularly granted to all his successors for life, sometimes at the first, sometimes at other subsequent parliaments, till the reign of Charles I.; when, as the noble historian expresses it, his ministers were not sufficiently solicitous for a renewal of his legal grant. And yet these imposts were imprudently and unconstitutionally levied and taken, without consent of parliament, for 15 years together; which was one of the causes of those unhappy discontents, justifiable at first in too many instances, but which degenerated at last into causeless rebellion and murder. For, as in every other, so in this particular case, the king (previous to the commencement of hostilities) gave the nation ample satisfaction for the errors of his former conduct, by passing an act, whereby he renounced all power in the crown of levying the duty of tonnage and poundage, without the express consent of parliament; and also all power of imposition upon any merchandises whatever. Upon the restoration, this duty was granted to King Charles II. for life, and so it was to his two immediate successors; but now, by three several statutes, 9 Ann. c. 6. 1 Geo. I. c. 12. and 3 Geo. I. c. 7. it is made perpetual, and mortgaged for the debt of the public.

Blackst. Comment. vol. i.

Tonnage, Tonquin.

TONQUIN, a kingdom of Asia, in the East Indies, beyond the Ganges; bounded on the north by the province of Yunnan in China, on the east by the province of Canton and the bay of Tonquin, on the south by Cochin China, and on the west by the kingdom of Laos. It is about 1200 miles in length and 500 in breadth; and is one of the finest and most considerable kingdoms of the East, as well on account of the number of inhabitants as the riches it contains and the trade it carries on. The country is thick set with villages; and the natives in general are of a middle stature and clean limbed, with a tawney complexion. Their faces are oval and flattish, and their noses and lips well proportioned. Their hair is black, long, lank, and coarse; and they let it hang down their shoulders. They are generally dexterous, nimble, active, and ingenious in mechanic arts. They weave a multitude of fine silks, and make curious lacker-works, which are transported to other countries. There is such a number of people, that many want employment; for they seldom go to work but when foreign ships arrive. The money and goods brought hither by the English and Dutch put them in action; for they have not money of their own sufficient to employ themselves; and therefore one-third at least must be advanced beforehand by the merchants: and the ships must stay here till the goods are finished, which is generally five or six months. They are so addicted to gaming, that when every thing else is lost, they will stake their wives and children. The garments of the Tonquinese are made either of silk or cotton; but the poor people and soldiers wear only cotton of a dark tawney colour. Their houses are small and low; and the walls either of mud, or hurdles daubed over with clay. They have only a ground floor, with two or three partitions; and each room has a square hole to let in the light. The villages consist of 30 or 40 houses, surrounded with trees; and in some places there are banks to keep the water from overflowing their gardens, where they have oranges, betels, melons, and salad-herbs. In the rainy season they cannot pass from one house to another without wading through the water; they sometimes have boats. In the capital city called *Cacho* there are about 20,000 houses with mud-walls, and covered with thatch; a few are built with brick, and roofed with pan-tiles. In each yard is a small arched building like an oven, about six feet high, made of brick, which serves to secure their goods in case of fire. The principal streets are very wide, and paved with small stones. The king of Tonquin has three palaces in it, such as they are; and near them are stables for his horses and elephants. The house of the English factory is seated at the north end of the city, fronting the river, and is the best in the city. The people in general are courteous, and civil to strangers; but the great men are proud, haughty, and ambitious; the soldiers insolent, and the poor thievish. They buy all

their

their wives, of which the great men have several; but the poor are stinted for want of money. In hard times the men will sell both their wives and children to buy rice to maintain themselves. The women offer themselves to strangers as wives while they stay, and agree with them for a certain price. Even the great men will offer their daughters to the merchants and officers who are likely to stay six months in the country. They are not afraid of being with child; for if they are girls they can sell them well when they are young, because they are fairer than the other inhabitants. These women are said to be very faithful; and are trusted with money and goods by the Europeans during their absence, and will make great advantage with them. The first new moon in the year that happens after the middle of January, is a great festival; when they rejoice for 10 or 12 days together, and spend their time in all manner of sports. Their common drink is tea, but they make themselves merry with arrack. The language is spoken very much in the throat; and some of the words are pronounced through the teeth, and has a great resemblance to the Chinese. They have several mechanic arts or trades; such as smiths, carpenters, joiners, turners, weavers, tailors, potters, painters, money-changers, paper-makers, workers in lacker, and bell-founders.—Their commodities are gold, musk, silks, calicoes, drugs of many sorts, woods for dyeing, lacquered wares, earthen wares, salt, aniseeds, and worm-seeds. The lacquered ware is not inferior to that of Japan, which is accounted the best in the world. The chief trade is carried on by the Chinese, English, and Dutch. Tonquin anciently formed part of the Chinese empire, but established its independence about 1553. From that period it was governed by its own princes till the year 1800, when after a long struggle it was finally conquered by the sovereign of Cochin China.

TONSILS. See ANATOMY, N° 102.

TONSURE, in *Ecclesiastical History*, a particular manner of shaving or clipping the hair of ecclesiastics or monks. The ancient tonsure of the clergy was nothing more than polling the head, and cutting the hair to a moderate degree, for the sake of decency and gravity: and the same observation is true with respect to the tonsure of the ancient monks. But the Romans have carried the affair of tonsure much farther; the candidate for it kneeling before the bishop, who cuts the hair in five different parts of the head, viz. before, behind, on each side, and on the crown.

TONTINE, a loan given for life annuities with benefit of survivorship; so called from the inventor Laurence Tonti, a Neapolitan. He proposed his scheme in 1653 to reconcile the people to Cardinal Mazazine's government, by amusing them with the hope of becoming suddenly rich. He obtained the consent of the court, but the parliament would not register the edict. He made attempts afterwards, but without success.

It was not till Louis XIV. was distressed by the league of Augsburg, and by his own immense expences, that he had recourse to the plans of Tonti, which, though long laid aside, were not forgotten. By an edict in 1689 he created a Tontine royale of 1,400,000 livres annual rent, divided into 14 classes. The actions were 300 livres a piece, and the proprietors were to receive 10l. per cent. with benefit of survivorship in every class. This scheme was executed but very imperfectly; for none of the classes rose to above 25,000 livres, instead of 100,000, according to the original institution; though the annuities were very regularly paid. A few years after, the people seeming in better humour for projects of this kind, another tontine was erected upon nearly the same terms, but this was never above half full. They both subsisted in the year 1726, when the French king united the 13th class of the first tontine with the 14th of the second; all the actions of which were possessed by Charlotte Bonneymay, widow of Louis Barbier, a surgeon of Paris, who died at the age of 96. This gentlewoman had ventured 300 livres in each tontine; and in the last year of her life she had for her annuity 73,500 livres, or about 3600l. a-year, for about 30l.

The nature of the tontine is this; there is an annuity, after a certain rate of interest, granted to a number of people; divided into classes, according to their respective ages; so that annually the whole fund of each class is divided among the survivors of that class; till at last it falls to one, and upon the extinction of that life, reverts to the power by which the tontine was erected, and which becomes thereby security for the due payment of the annuities.

TOOL, among mechanics, denotes in general any instrument used for making other complex instruments and machines, or in other operations of the mechanic arts.

TOOTH, for a description of, see ANATOMY, N° 27.

TOOTHACH. See MEDICINE, N° 210, and SURGERY *Index*.

TOOTHACH-Tree. See ZANTHOXYLUM, } BOTANY *Index*.
TOOTHWORT. See PLUMBAGO, }

TOP, a sort of platform, surrounding the lower masthead, from which it projects on all sides like a scaffold.

The principal intention of the top is to extend the topmast shrouds, so as to form a greater angle with the mast, and thereby give additional support to the latter. It is sustained by certain timbers fixed across the hounds or shoulders of the masts, and called the *trestle-trees* and *cross-trees*.

Besides the use above mentioned, the top is otherwise extremely convenient to contain the materials necessary for extending the small sails, and for fixing or repairing the rigging and machinery with more facility and expedition. In ships of war it is used as a kind of redoubt, and is accordingly fortified for attack or defence; being furnished with swivels, musketry, and other fire-arms, and guarded by a thick fence of corded hammocks. Finally, it is employed as a place for looking out, either in the day or night.

TOP-Mast, the second division of a mast, or that part which stands between the upper and lower pieces. See the article MAST.

TOP-Sails, certain large sails extended across the topmasts by the top-sail yard above, and by the yard attached to the lower mast beneath; being fastened to the former by robands, and to the later by means of two great blocks fixed on its extremities, through which the topsail-sheets are inserted, passing from thence to two other blocks fixed on the inner part of the yard close

close by the mast; and from these latter the sheets lead downwards to the deck, where they may be slackened or extended at pleasure. See the article SAIL.

TOPAZ, a gem or precious stone. See MINERALOGY *Index*.

TOPE, a species of SQUALUS. See ICHTHYOLOGY *Index*.

TOPHET. See HINNOM and MOLOCH.

TOPHUS, in *Medicine*, denotes a chalky or stony concretion in any part of the body; as the bladder, kidney, &c. but especially in the joints.

TOPIC, a general head or subject of discourse.

TOPICS, in *Oratory*. See ORATORY, N° 10—13.

TOPICS, or *Topical Medicines*, are the same with external remedies, or those applied outwardly to some diseased and painful part: such are plasters, cataplasms, unguents, &c.

TOPOGRAPHY, a description or draught of some particular place, or small tract of land, as that of a city or town, manor, or tenement, field, garden, house, castle, or the like; such as surveyors set out in their plots, or make draughts of, for the information and satisfaction of the proprietors.

TOPSHAM, a town in Devonshire, in England, seated on the river Exmouth, five miles south-east of Exeter, to which place the river was formerly navigable; but in time of war was choaked up designedly, so that ships are now obliged to load and unload at Topsham. W. Long. 3. 26. N. Lat. 50. 30.

TORBAY, a fine bay of the English channel, on the coast of Devonshire, a little to the east of Dartmouth, formed by two capes, called *Bury Points*, and *Bob's Nose*.

TORDA, or RASOR-BILL. See ALCA, ORNITHOLOGY *Index*.

TORDYLIUM, HART-WORT, a genus of plants belonging to the class of pentandria, and in the natural system arranged under the 45th order, *Umbellatæ*. See BOTANY *Index*.

TORIES, a political faction in Britain, opposed to the Whigs.

The name of *Tories* was given to a sort of banditti in Ireland, and was thence transferred to the adherents of Charles I. by his enemies, under the pretence that he favoured the rebels in Ireland. His partisans, to be even with the republicans, gave them the name of *Whigs*, from a word which signifies *whey*, in derision of their poor fare. The Tories, or *cavaliers*, as they were also called, had then principally in view the political interest of the king, the crown, and the church of England; and the round-heads, or Whigs, proposed chiefly the maintaining of the rights and interests of the people, and of Protestantism. This is the most popular account; and yet it is certain the names *Whig* and *Tory* were but little known till about the middle of the reign of King Charles II. M de Cize relates, that it was in the year 1678 that the whole nation was first observed to be divided into Whigs and Tories; and that on occasion of the famous deposition of Titus Oates, who accused the Catholics of having conspired against the king and the state, the appellation of *Whig* was given to such as believed the plot real; and *Tory* to those who held it fictitious.

These parties may be considered either with regard to the state or to religion. The state Tories are either violent or moderate: the first would have the king to be absolute, and therefore plead for passive obedience, non-resistance, and the hereditary right of the house of Stuart. The moderate Tories would not suffer the king to lose any of his prerogative; but then they would not sacrifice those of the people. The state Whigs are either strong republicans or moderate ones. The first (says Rapin) are the remains of the party of the long parliament, who attempted to change monarchy to a commonwealth: but these make so slender a figure, that they only served to strengthen the party of other Whigs. The Tories would persuade the world, that all the Whigs are of this kind; as the Whigs would make us believe that all the Tories are violent. The moderate state Whigs are much in the same sentiments with the moderate Tories, and desire that the government may be maintained on the ancient foundation: all the difference is, that the first bear a little more to the parliament and people, and the latter to that of the king. In short, the old Whigs were always jealous of the encroachments of the royal prerogative, and watchful over the preservation of the liberties and properties of the people.

TORMENTILLA, TORMENTIL, a genus of plants belonging to the class of icosandria, and in the natural system ranging under the 35th order, *Senticosæ*. See BOTANY *Index*.

TORNADO, a sudden and vehement gust of wind from all points of the compass, frequent on the coast of Guinea.

TORPEDO, the CRAMP-FISH. See RAJA, ICHTHYOLOGY *Index*.

TORPOR, a numbness, or defect of feeling and motion. Galen says it is a sort of intermediate disorder between palsy and health.

TORREFACTION, in *Chemistry*, is the roasting or scorching of a body by the fire, in order to discharge a part either unnecessary or hurtful in another operation. Sulphur is thus discharged from an ore before it can be wrought to advantage.

TORRENT, denotes a temporary stream of water falling suddenly from mountains, whereon there have been great rains or an extraordinary thaw of snow.

TORRICELLI, EVANGELISTE, an illustrious Italian mathematician and philosopher, born at Faenza in 1608. He was trained in Latin literature by his uncle a monk; and after cultivating mathematical knowledge for some time without a master, he studied it under Father Benedict Castelli, professor of mathematics at Rome. Having read Galileo's dialogues, he composed a treatise on motion, on his principles, which brought him acquainted with Galileo, who took him home as an assistant: but Galileo died in three months after. He became professor of mathematics at Florence, and greatly improved the art of making telescopes and microscopes: but he is best known for finding out a method of ascertaining the weight of the atmosphere by quicksilver; the barometer being called, from him, the *Torricellian tube*. He published *Opera Geometrica*, 4to, 1644; and died in 1647.

TORRICELLIAN EXPERIMENT, a famous experiment made by Torricelli, by which he demonstrated the pressure of the atmosphere in opposition to the doctrines of suction, &c. finding that pressure able to support only a a certain length of mercury, or any other fluid, in an inverted glass tube. See BAROMETER.

TORSK, or TUSK. See GADUS, ICHTHYOLOGY *Index*.

TORTOISE. See TESTUDO, ERPETOLOGY *Index*.

Phil. Trans. N° 435. p. 117. *TORTOISE shell*, the shell, or rather scales, of the testaceous animal called a *tortoise;* used in inlaying, and in various other works, as for snuff-boxes, combs, &c. Mr Catesby observes, that the hard strong covering which incloses all sorts of tortoises, is very improperly called a *shell;* being of a perfect bony contexture; but covered on the outside with scales, or rather plates, of a horny substance; which are what the workmen call *tortoise-shell*.

There are two general kinds of tortoises, viz. the *land* and *sea tortoise*, *testudo terrestris* and *marina*. The sea-tortoise, again, is of several kinds; but it is the caret, or testudo imbricata of Linnæus, alone which furnishes that beautiful shell so much admired in Europe.

The shell of the caretta, or hawksbill tortoise, is thick; and consists of two parts, the upper, which covers the back, and the lower the belly: the two are joined together at the sides by strong ligaments, which yet allow of a little motion. In the fore-part is an aperture for the head and fore-legs, and behind for the hind-legs and tail. It is the under shell alone that is used: to separate it, they make a little fire beneath it, and as soon as ever it is warm, the under shell becomes easily separable with a point of a knife, and is taken off in laminæ or leaves.

The whole spoils of the caret consist in 13 leaves or scales, eight of them flat, and five a little bent. Of the flat ones, there are four large ones, sometimes a foot long, and seven inches broad. The best tortoise-shell is thick, clear, transparent, of the colour of antimony, sprinkled with brown and white. When used in marquetry, &c. the workmen give it what colour they please by means of coloured leaves, which they put underneath it.

Working and joining of TORTOISE-shell.—Tortoise-shell and horn become soft in a moderate heat, as that of boiling water, so as to be pressed, in a mould, into any form, the shell or horn being previously cut into plates of a proper size. Plumier informs us, in his *Art de Turner*, that two plates are likewise united into one by heating and pressing them; the edges being thoroughly cleaned, and made to sit close to one another. The tortoise-shell is conveniently heated for this purpose by applying a hot iron above and beneath the juncture, with the interposition of a wet cloth to prevent the shell from being scorched by the irons: these irons should be pretty thick, that they may not lose their heat before the union is effected. Both tortoise-shell and horns may be stained of a variety of colours, by means of the colouring drugs commonly used in dyeing, and by certain metallic solutions.

TORTURE, a violent pain inflicted on persons to force them to confess the crimes laid to their charge, or as a punishment for crimes committed.

Torture was never permitted among the Romans except in the examination of slaves: it would therefore appear, that it was a general opinion among them, that a slave had such a tendency to falsehood, that the truth could only be extorted from him. To the disgrace of the professors of Christianity, torture was long practised by those who called themselves Catholics, against those whom they termed *heretics;* that is, those who differed in opinion from themselves. Finding that they could not bring over others to adopt their sentiments by the force of argument, they judged it proper to compel them by the force of punishment. This practice was very general among orthodox Christians, but especially among Roman Catholics. See INQUISITION.

By the law of England, torture was at one period employed to compel those criminals who stood obstinately mute when brought to trial, and refused either to plead guilty or not guilty; but it is now abolished (see ARRAIGNMENT, and RACK). A history of the machines which have been invented to torture men, and an account of the instances in which they have been employed, would exhibit a dismal picture of the human character.

TORUS, in *Architecture*, a large round moulding used in the bases of columns. See ARCHITECTURE.

TOUCAN. See RHAMPHASTOS, ORNITHOLOGY *Index*.

TOUCH-NEEDLE, among assayers, refiners, &c. little bars of gold, silver, and copper, combined together, in all the different proportions and degrees of mixture; the use of which is to discover the degree of purity of any piece of gold or silver, by comparing the mark it leaves on the touchstone with those of the bars.

The metals usually tried by the touchstone are gold, silver, and copper, either pure, or mixed with one another in different degrees and proportions, by fusion. In order to find out the purity or quantity of baser metal in these various admixtures, when they are to be examined they are compared with these needles, which are mixed in a known proportion, and prepared for this use. The metals of these needles, both pure and mixed, are all made into laminæ or plates, one-twelfth of an inch broad, and of a fourth part of their breadth in thickness, and an inch and half-long; these being thus prepared, you are to engrave on each a mark indicating its purity, or the nature and quantity of the admixture in it. The black rough marbles, the basaltes, or the softer kinds of black pebbles, are the most proper for touchstones.

The method of using the needles and stone is thus: The piece of metal to be tried ought first to be wiped well with a clean towel or piece of soft leather, that you may the better see its true colour; for from this alone an experienced person, will in some degree, judge beforehand what the principal metal is, and how and with what debased.

Then choose a convenient, not over large, part of the surface of the metal, and rub it several times very hardly and strongly against the touchstone, that in case a deceitful coat or crust should have been laid upon it, it may be worn off by that fricton: this, however, is more readily done by a grindstone or small file. Then wipe a flat and very clear part of the touchstone, and rub against it, over and over, the just-mentioned part of the surface of the piece of metal, till you have, on the flat surface of the stone, a thin metallic crust, an inch long, and about an eighth of an inch broad: this done, look out the needle that seems most like to the metal under trial, wipe the lower part of this needle

very

Touch-Needle ‖ Toulon.

very clean, and then rub it against the touchstone, as you did the metal, by the side of the other line, and in a direction parallel to it.

When this is done, if you find no difference between the colours of the two marks made by your needle and the metal under trial, you may with great probability pronounce that metal and your needle to be of the same alloy, which is immediately known by the mark engraved on your needle. But if you find a difference between the colour of the mark given by the metal, and that by the needle you have tried, choose out another needle, either of a darker or lighter colour than the former, as the difference of the tinge on the touchstone directs; and by one or more trials of this kind you will be able to determine which of your needles the metal answers, and thence what alloy it is of, by the mark of the needle; or else you will find that the alloy is extraordinary, and not to be determined by the comparison of your needles.

Touchstone, a black, smooth, glossy stone, used to examine the purity of metals. The ancients called it *lapis Lydius*, the Lydian stone, from the name of the country whence it was originally brought.

Any piece of peeble or black flint will answer the purposes of the best lapis Lydius of Asia. Even a piece of glass made rough with emery is used with success, to distinguish true gold from such as is counterfeit; both by the metallic colour and the test of aquafortis. The true touchstone is of a black colour, and is not uncommon in many parts of the world.

TOUCHWOOD. See Boletus, Botany *Index*.

TOULON, a celebrated city and seaport of France, in that part of the late province of Provence which is now denominated the department of the *Var*. It is a very ancient place, having been founded, according to the common opinion, by a Roman general. It is the chief town of the department, and before the great revolution in 1789 was an episcopal see. The inhabitants were computed at 29,000 in 1817. It is divided into the Old Quarter and the New Quarter. The first, which is very ill built, has nothing remarkable in it but the *Rue aux Arbres*, the Tree-Street, which is a kind of course or mall, and the town-house; the gate of this is surrounded by a balcony, which is supported by two termini, the masterpieces of the famous Pujet. The New Quarter, which forms as it were a second city, contains, beside the magnificent works constructed in the reign of Louis XIV. many fine houses (among which that of the late seminary merits beyond comparison the preference) and a grand oblong square, lined with trees, and serving as a parade.

The Merchants Haven, along which extends a noble quay, on which stands the town-house, is protected by two moles, begun by Henry IV. The New Haven was constructed by Louis XIV. as were the fortifications of the city. In the front of this haven is an arsenal, containing all the places necessary for the construction and fitting out of vessels: the first object that appears is a rope-walk, entirely arched, extending as far as the eye can reach, and built after the designs of Vauban: here cables are made, and above is a place for the preparation of hemp. Here likewise is the armoury for muskets, pistols, halberds, &c. In the park of artillery are cannons placed in piles, bombs, grenades, mortars, and balls of vurious kinds, ranged in wonderful order. The long-sail-room, the foundery for cannon, the dockyards, the basons, &c. are all worthy of observation.

Toulon, Toulouse.

Both the Old and New Port have an outlet into the spacious outer road or harbour, which is surrounded by hills, and formed by nature almost circular. Its circuit is of very great extent, and the entrance is defended on both sides by a fort with strong batteries. In a word, the basons, docks, and arsenal, at Toulon, warranted the remark of a foreigner that visited them in the late reign, that "the king of France was greater there than at Versailles." Toulon is the on y mart in the Mediterranean for the re-exportation of the products of the East Indies.

This place was destroyed toward the end of the tenth century, and pillaged by the African pirates almost as soon as rebuilt. The constable of Bourbon, at the head of the Imperial troops, obtained possession of it in 1524, as did Charles V. in 1536; but in the next century Charles Emanuel duke of Savoy could not enter it, and Prince Eugene in 1707 ineffectually laid siege to it. This city was surrendered by the inhabitants in September 1793 to the British admiral Lord Hood, as a condition and means of enabling them to effect the re-establishment of monarchy in France, according to the constitution of 1789. Lord Hood accordingly, in conjunction with the Spanish land and naval forces, took possion of the harbour and forts in trust for Louis XVII. It was garrisoned for some time by the British troops, and their allies the Spaniards, Neapolitans, and Sardinians; but the French having laid seige to it, the garrison was obliged to evacuate the place in the month of December following, after having destroyed the grand arsenal, two ships of 84 guns, eight of 74, and two frigates; and carried off the Commerce de Marseilles, a ship of 120 guns, with an 80 and 74 gun ship. This exploit was most gallantly performed, after it was found impossible to defend the town, or to carry off the ships. Lord Hood entrusted the management of the affair to Sir Sydney Smith, so distinguished for his intrepidity. Captain Hare commanded the fireship which was towed into the grand arsenal; and so eager was he to execute his orders, that instead of setting fire to the train in the usual cautious manner, he fired a pistol loaded with powder into the bowl of the train, composed of 36 pounds of powder and other combustibles. The consequence was, he was blown into the water with such violence, as to knock a lieutenant of the Victory's boat overboard, and narrowly escaped with his life. A Spanish captain was appointed to set fire to the small arsenal, but cowardice prevented him from executing his orders; and this is the reason why the whole French ships were not destroyed. We have been favoured with this account by an officer of the British fleet.

Toulon is seated on a bay of the Mediterranean, 17 leagues south-east of Aix, 15 south-east of Marseilles, and 217 south-east of Paris. E. Long. 5. 56. N. Lat. 43. 7.

TOULOUSE, a very ancient city of France, in the department of Upper Garonne, and late province of Languedoc, with an archbishop's see. It is one of the most considerable cities in the south of France, although its population bears no proportion to its extent. In 1817 it was estir ed to contain 48,000 inhabitants. The streets are ver hand-some,

some, and the walls of the city, as well as the houses, are built with bricks. The town-house, a modern structure, forms a perfect square, 324 feet long and 66 high. The principal front occupies an entire side of the grand square, lately called the *Place Royale*. In the great hall, called the *Hall of Illustrious Men*, is the statue of the Chevalier Isaure, and the busts of all the great men to whom Toulouse has given birth. Communicating with the ocean on one side by the river Garonne, and with the Mediterranean on the other by the canal of Languedoc, Toulouse might have been a great commercial city; but the taste of the inhabitants has been directed to the sciences and belles-lettres. Of course, there are two colleges, two public libraries, and three academies. The little commerce of Toulouse consists in leather, drapery, blankets, mignionets, oil, iron, mercery, hardware, and books. The bridge over the Garonne is at least equal to those of Tours and Orleans; it forms the communication between the suburb of St Cyprian and the city. A bloody battle was fought at Toulouse on the 10th April 1814, between the British army under Lord Wellington, and the French army under Soult, in which the latter was defeated with great loss. Toulouse is 37 miles east of Auch, 125 south-east of Bourdeaux, and 350 south-by-west of Paris. E. Long. 1. 32. N. Lat. 43. 36.

TOUR, Henry de la, Viscount Turenne, a celebrated French general, was the second son of Henry de la Tour duke of Bouillon, and was born at Sedan in 1611. He made his first campaigns in Holland, under Maurice and Frederic Henry princes of Orange; who were his uncles by the mother's side; and even then distinguished himself by his bravery. In 1634 he marched with his regiment into Lorraine; and having contributed to the taking of La Mothe, was, though very young, made mareschal de camp. In 1636 he took Saverne, and the year following the castles of Hirson and Sole; on which occasion he performed an action like that of Scipio's, with respect to a very beautiful woman whom he sent back to her husband. The viscount Turenne continued to distinguish himself in several sieges and battles, and in 1644 was made marshal of France; but had the misfortune to be defeated at the battle of Mariendal in 1645. However, he gained the battle of Nortlingen three months after; restored the elector of Treves to his dominions; and the following year made the famous junction of the French army with that of Sweden commanded by General Wrangel, which obliged the duke of Bavaria to demand a peace. Afterwards that duke breaking the treaty he had concluded with France, he was defeated by the viscount Turenne at the battle of Zumarshausen, and in 1648 driven entirely out of his dominions. During the civil wars in France, he sided with the princes, and was defeated at the battle of Rhetel in 1650; but soon after was restored to the favour of the king, who in 1652 gave him the command of his army. He acquired great honour at the battles of Jergeau, Gren, and the suburbs of St Anthony, and by the retreat he made before the army commanded by the princes at Ville Neuve St George. In 1654 he made the Spaniards raise the siege of Arras: the next year he took Conde, St Guilian, and several other places; gained the famous battle of Dunes; and made himself master of Dunkirk, Oudenarde, and almost all Flanders: this obliged the Spaniards to conclude the peace of the Pyrenees in 1660. These important services occasioned his being made marshal-general of the king's camps and armies. The war being renewed with Spain in 1667, Turenne commanded in Flanders; and took so many places, that in 1668 the Spaniards were obliged to sue for peace. He commanded the French army in the war against the Dutch in 1672; took 40 towns in 22 days; pursued the elector of Brandenburg even to Berlin; gained the battles of Slintsheim, Ladenburg, Ensheim, Mulhausen, and Turkeim; and obliged the Imperial army, which consisted of 70,000 men, to repass the Rhine. By this campaign the viscount Turenne acquired immortal honour. He passed the Rhine to give battle to General Montecuculi, whom he followed as far as Saspach; but mounting upon an eminence to discover the enemy's camp, he was killed by a cannon-ball in 1675. All France regretted the loss of this great man, who, by his military exploits, had raised the admiration of Europe.

TOURAINE, a province of France, bounded on the north by Maine, on the east by Orleanois, on the south by Berris, and on the west by Anjou and Poitou. It is about 58 miles in length, and 55 in breadth where it is broadest. This country is watered by 17 rivers, besides many brooks, which not only render it delightful, but keep up a communication with the neighbouring provinces. The air is temperate, and the soil is so fruitful that it is called the *garden of France*. It now forms the department of Indre and Loire, of which Tours is the capital.

TOURMALINE, a species of mineral belonging to the siliceous genus. See Mineralogy *Index*.

TOURNAMENT, a martial sport or exercise which the ancient cavaliers used to perform, to show their bravery and address. It is derived from the French word *tourner*, i. e. "to turn round," because to be expert in these exercises, much agility both of horse and man was requisite, they riding round a ring in imitation of the ancient Circi.

The first tournaments were only courses on horseback, wherein the cavaliers tilted at each other with canes in manner of lances; and were distinguished from justs, which were courses or careers, accompanied with attacks and combats, with blunted lances and swords. See Just.

The prince who published the tournament, used to send a king at arms, with a safe-conduct, and a sword, to all the princes, knights, &c. signifying that he intended a tournament and clashing of swords, in the presence of ladies and damsels; which was the usual formula of invitation.

They first engaged man against man, and then troop against troop; and, after the combat, the judges allotted the prize to the best cavalier, and the best striker of swords; who was accordingly conducted in pomp to the lady of the tournament; where, after thanking her very reverently, he saluted her and likewise her two attendants.

These tournaments made the principal diversion of the 13th and 14th centuries. Munster says, it was Henry the Fowler, duke of Saxony, and afterwards emperor, who died in 936, that first introduced them; but it appears from the chronicle of Tours, that the true inventor of this famous sport, at least in France, was one Geoffrey, lord of Preuilli, about the year 1066.

Instances of them occur among the English in the reign of King Stephen, about the year 1140; but they were not much in use till Richard's time, towards the year 1149. After which period these diversions were performed with extraordinary magnificence in the Tilt-yard near St James's, Smithfield, and other places.

The following is the account of a tournament, from Maitland. King Richard II. designing to hold a tournament at London on the Sunday after Michaelmas, sent divers heralds to make proclamation of it in all the principal courts of Europe; and accordingly not a few princes, and great numbers of the prime nobility, resorted hither from France, Germany, the Netherlands, &c. This solemnity began on Sunday afternoon, from the Tower of London, with a pompous cavalcade of 60 ladies, each leading an armed knight by a silver chain, being attended by their 'squires of honour, and, passing through Cheapside, rode to Smithfield, where the justs and tournaments continued several days with magnificent variety of entertainments; on which occasion the king kept open house at the bishop of London's palace for all persons of distinction, and every night concluded with a ball.

At last, however, they were found to be productive of bad effects, and the occasions of several fatal misfortunes—as in the instance of Henry II. of France, and of the tilt exhibited at Chalons, which, from the numbers killed on both sides, was called the *little war of Chalons*. These and other inconveniencies, resulting from those dangerous pastimes, gave the popes occasion to forbid them, and the princes of Europe gradually concurred in discouraging and suppressing them.

TOURNAY, a town of the Netherlands in Flanders, and capital of a district called *Tournaysis*, with a bishop's see. It is divided into two parts by the river Scheldt, is well built, and contained 21,300 inhabitants in 1800. It carries on a great trade in woollen stuffs and stockings. The cathedral is a very handsome structure, and contains a great many chapels, and several magnificent tombs of marble and brass. The town was taken by the allies in 1709; but was ceded to the house of Austria by the treaty of Utrecht, though the Dutch had a right to put in a garrison. It was taken by the French in June 1745, who demolished the fortifications. In 1781 the emperor Joseph II. obliged the Dutch to withdraw their garrison. It was taken by the French in 1791, abandoned in 1793, again conquered by them in 1794, and finally united to the kingdom of the Netherlands in 1814. It is 14 miles south-east of Lisle, and 135 north-by-east from Paris. E. Long. 3. 25. N. Lat. 50. 35.

TOURNEFORT, Joseph Pitton de, a famous French botanist, was born at Aix in Provence in 1656. He had a passion for plants from his childhood, which overcame his father's views in putting him to study philosophy and divinity; therefore on his death he quitted theology, and gave himself up entirely to physic, natural history, and botany. He wandered over the mountains of Dauphiny, Savoy, Catalonia, the Pyrenees, and the Alps, in search of new species of plants, which he acquired with much fatigue and danger. His fame in 1683 procured him the employment of botanic professor, in the king's garden; and by the king's order, he travelled into Spain, Portugal, Holland, and England, where he made prodigious collections of plants. In 1700, Mr Tournefort, in obedience to another order, simpled over all the isles of the Archipelago, upon the coasts of the Black sea, in Bithynia, Pontus, Cappadocia, Armenia, and Georgia; making observations on natural history at large, ancient and modern geography, religion, manners, and commerce. He spent three years in this learned voyage; and then resuming his profession, was made professor of physic in the college-royal. He died in consequence of an accidental crush of his breast by a cart-wheel, which brought on a spitting of blood and hydrothorax, that carried him off in 1708. He wrote Elements of Botany, both in French and Latin; A relation of his Voyage into the Levant; with other pieces of less consideration.

TOURNIQUET, in *Surgery*, an instrument formed with screws, for compressing any part with rollers, &c for the stopping of hæmorrhagies. See Surgery *Index*.

TOWER, a tall building consisting of several stories, usually of a round form, though some are square or polygonal. Towers are built for fortresses, &c. as the Tower of London. See London, N° 46.

TOWN, a place inhabited by a considerable number of people, being of a middle size between a city and a village.

TOXICODENDRON. See Rhus, Botany *Index*.

TRAAS. See Terras.

TRACHEA. See Anatomy, N° 119.

TRACHINUS, the Weever, a genus of fishes belonging to the order of jugulares. See Ichthyology *Index*.

TRACT, in *Geography*, an extent of ground, or a portion of the earth's surface.

Tract, in matters of literature, denotes a small treatise or written discourse upon any subject.

TRADE, in general, denotes the same with commerce, consisting in buying, selling, and exchanging of commodities, bills, money, &c. See Commerce, Coin, Money, Company, &c.

Trade-Winds, denote certain regular winds at sea, blowing either constantly the same way, or alternately this way and that; thus called from their use in navigation, and the Indian commerce. See Meteorology.

TRADESMEN's tokens, a term synonymous among medalists with provincial coins.

This is a subject curious enough to deserve attention, though we will not go so far as Mr Pinkerton does, who says that it is a subject in which the perpetual glory of the nation is interested. Since the year 1789 provincial halfpence have been made and circulated in considerable quantity. As ancient medals and coins have been frequently of use to historians, it is to be regretted that many of these provincial halfpence are rendered useless in this respect by unmeaning figures and puerile devices. Utility and elegance ought to be studied: for this view it has been proposed by a gentleman of taste on this subject, that all coins should be distinguished by one of the following five characteristics. 1. Fac similes of magnificent beautiful buildings. 2. Representations of great and useful undertakings. 3. Emblems of the industry and commerce of the age. 4. The illustrious men, &c. to whom the nation has given birth. 5. Important historical events.

TRADITION, something handed down from one generation to another without being written. Thus the Jews

Jews pretended, that besides their written law contained in the Old Testament, Moses had delivered an oral law which had been conveyed down from father to son; and thus the Roman Catholics are said to value particular doctrines supposed to have descended from the apostolic times by tradition.

TRAGACANTH. See ASTRAGALUS, MATERIA MEDICA *Index*.

TRAGEDY, a dramatic poem, representing some signal action performed by illustrious persons, and which has frequently a fatal issue or end. See POETRY, Part II. sect. I.

TRAGI-COMEDY; a dramatic piece, partaking both of the nature of tragedy and comedy; in which a mixture of merry and serious events is admitted.

TRAGOPOGON, GOAT'S-BEARD; a genus of plants belonging to the class of syngenesia; and in the natural system ranging under the 49th order *Compositæ*. See BOTANY *Index*.

TRAJAN, MARCUS ULPIUS, a celebrated Roman emperor, who gained many victories over the Parthians and Germans, pushing the empire to its utmost extent on the east and north sides. He died at Silinunte, a city of Cilicia, which from him was called *Trajanopolis*, in the year 117.

TRAJAN's Column, a famous historical column erected in Rome, in honour of the emperor Trajan. It is of the Tuscan order, though somewhat irregular: its height is eight diameters, and its pedestal Corinthian: it was built in a large square called *Forum Romanum*. Its base consists of 12 stones of an enormous size, and is raised on a socle, or foot, of eight steps: within side is a staircase illuminated with 44 windows. It is 140 feet high, which is 35 feet short of the Antonine column, but the workmanship of the former is much more valued. It is adorned from top to bottom with basso relievos, representing the great actions of the emperor against the Dacians.

TRAIN, a line of gunpowder laid to give fire to a quantity thereof, in order to do execution by blowing up earth, works, buildings, &c.

TRAIN of Artillery, includes the great guns and other pieces of ordnance belonging to an army in the field.

TRAIN-Oil, the oil procured from the blubber of a whale by boiling.

TRALLIAN, ALEXANDER, a Greek writer on physic, a native of Tralles in Lydia, who lived about the middle of the sixth century. His works are divided into 12 books; in which he treats of distempers as they occur from head to foot. He was the first who opened the jugular vein, and that used cantharides as a blister for the gout. Dr Freind, in his History of Physic, styles him one of the most valuable authors since the time of Hippocrates. Though he appears on the whole to have been a rational physician, yet there are things in his writings that savour of enthusiasm and superstition.

TRA-LOS-MONTES, a province of Portugal, called in Latin *Transmontana*, because situated on the east side of a chain of hills that separate it from Entre Ducro-e-Minho. It is bounded on the north by Galicia; on the south by the provinces of Beira and Leon; by the last of which it is bounded also to the east. Its length from north to south is upwards of 120 miles, and its breadth about 80. It is full of mountains, and produces little corn, but plenty of wine, fruits of several sorts, and abundance of game.

TRANSACTIONS, a name generally given to a collection of the papers read before literary or philosophical societies. The name of *Philosophical Transactions* was first adopted by the Royal Society of London.

The Philosophical Transactions to the end of the year 1700 were abridged in three volumes by Mr John Lowthorp: those from the year 1700 to 1720 were abridged in two volumes by Mr Henry Jones: those from 1719 to 1733 were abridged in two volumes by Mr John Eames and Mr John Martyn; Mr Martyn continued the abridgement of those from 1732 to 1744 in two volumes, and of those from 1743 to 1750 in two volumes.

They were for many years published in numbers, and the printing of them was always, from time to time, the single act of the respective secretaries, till the year 1752, when the society thought fit that a committee should be appointed to reconsider the papers read before them, and to select out of them such as they should judge most proper for publication in the future Transactions. They are published annually in two parts at the expence of the society, and each fellow is entitled to receive one copy *gratis* of every volume published after his admission into the society.

They were first set on foot in 1665, by Mr Oldenburg, secretary of the society, and were continued by him till the year 1677. Upon his death, they were discontinued till January 1678, when Dr Grew resumed the publication of them, and continued it for the months of December 1678, and January and February 1679, after which they were intermitted till January 1683. During this last interval they were supplied in some measure by Dr Hooke's Philosophical Collections. They were also interrupted for three years, from December 1687 to January 1691, beside other smaller interruptions, amounting to near one year and a half more, before October 1695, since which time the Transactions have been regularly carried on.

TRANSCENDENTAL, or TRANSCENDENT, something elevated, or raised above other things; which passes and transcends the nature of other inferior things.

TRANSCRIPT, a copy of any original writing, particularly that of an act or instrument inserted in the body of another.

TRANSFER, in commerce, an act whereby a person surrenders his right, interest, or property, in any thing moveable or immoveable, to another.

TRANSFORMATION, in general, denotes a change of form, or the assuming a new form different from a former one.

TRANSFUSION, the act of pouring a liquor out of one vessel into another.

TRANSFUSION of Blood, an operation by which it was some time ago imagined that the age of animals would be renewed, and immortality, or the next thing to it, conferred on those who had undergone it.

The method of transfusing Dr Lower gives us to the following effect: take up the carotid artery of the dog, or other animal, whose blood is to be transfused into another of the same, or a different kind: separate it from the nerve of the eighth pair, and lay it bare above an inch. Make a strong ligature on the upper part of the artery; and an inch nearer the heart another ligature with a running knot, to be loosened and fastened as occasion requires. Draw two threads between the two ligatures, open the artery, put in a quill, and tie up the artery again upon the quill by the two threads, and stop the quill by a stick.

Then make bare the jugular vein of the other animal for about an inch and a half in length, and at each end make a ligature with a running knot; and in the space between the two knots draw under the veins two threads, as in the other. Open the vein, and put into it two quills, one into the descending part of the vein, to receive the blood from the other dog, and carry it to the heart; the other quill put into the other part of the jugular, towards the head, through which the second animal's own blood is to run into dishes. The quills thus tied fast, stop them up with sticks till there be occasion to open them.

Things thus disposed, fasten the dogs on their sides towards one another, in such a manner as that the quills may go into each other; then unstop the quill that goes down into the second dog's jugular vein, as also that coming out of the other dog's artery; and by the help of two or three other quills put into each other, as there shall be occasion, insert them into one another. Then slip the running knots, and immediately the blood runs through the quills as through an artery, very impetuously. As the blood runs into the dog, unstop the quill in the upper part of his jugular, for his own blood to run out at, though not constantly, but as you perceive him able to bear it, till the other dog begins to cry and faint, and at last die. *Lastly*, Take both quills out of the jugular, tie the running knot fast, and cut the vein asunder, and sew up the skin: the dog, thus dismissed, will run away as if nothing ailed him.

In the Philosophical Transactions we have accounts of the success of various transfusions practised at London, Paris, in Italy, &c. Sir Edmund King transfused forty-nine ounces of blood out of a calf into a sheep; the sheep, after the operation, appearing as well and as strong as before.

M. Denis transfused the blood of three calves into three dogs, which all continued brisk, and ate as well as before. The same person transfused the blood of four wethers into a horse twenty-six years old, which thence received much strength, and a more than ordinary appetite.

Soon after this operation was introduced at Paris, viz. in 1667 and 1668, M. Denis performed it on five human subjects, two of whom recovered of disorders under which they laboured; one being in perfect health suffered no inconvenience from it; and two persons who were ill, and submitted to the operation, died; in consequence of which the magistrates issued a sentence, prohibiting the transfusion on human bodies under pain of imprisonment.

Mr John Hunter, we are told, made many ingenious experiments to determine the effects of transfusing blood, some of which are sufficient to attract attention. But whether such experiments can ever be made with safety on the human body, is a point not easily determined. They might be allowed in desperate cases proceeding from a corruption of the blood, from poison, &c. as in hydrophobia.

TRANSIT, from *transit*, "it passes over," signifies the passage of any planet over the sun, moon, or stars.

TRANSITION, the passage of any thing from one place to another.

TRANSITION, in *Oratory*. See ORATORY, N° 39.

TRANSITIVE, in *Grammar*, an epithet applied to such verbs as signify an action which passes from the subject that does it, to or upon another subject which receives it. Under the head of verbs transitive come what we usually call *verbs active* and *passive*; other verbs, whose action does not pass out of themselves, are called *neuters*.

TRANSLATION, the act of transferring or removing a thing from one place to another; as we say, the translation of a bishop's see, a council, a seat of justice, &c.

TRANSLATION is also used for the version of a book or writing out of one language into another.

The principles of translation have been clearly and accurately laid down by Dr Campbell of Aberdeen in his invaluable Preliminary Dissertations to his excellent translations of the gospels. The fundamental rules which he establishes are three: 1. That the translation should give a complete transcript of the ideas of the original. 2. That the style and manner of the original should be preserved in the translation. 3. That the translation should have all the ease of original composition. The rules deducible from these general laws are explained and illustrated with much judgment and taste, in an Essay on the Principles of Translation, by Mr Tytler, judge-advocate of Scotland.

TRANSMARINE, something that comes from or belongs to the parts beyond sea.

TRANSMIGRATION, the removal or translation of a whole people into another country, by the power of a conqueror.

TRANSMIGRATION is particularly used for the passage of the soul out of one body into another. See METEMPSYCHOSIS.

TRANSMUTATION, the act of changing one substance into another.

Nature, says Sir Isaac Newton, is delighted with transmutation: water, which is a fluid, volatile, tasteless salt, is, by heat, transmuted into vapour, which is a kind of air; and by cold into ice, which is a cold, transparent, brittle stone, easily dissolvable; and this stone is convertible again into water by heat, as vapour is by cold.—Earth, by heat, becomes fire, and, by cold, is turned into earth again: dense bodies, by fermentation, are rarefied into various kinds of air; and that air, by fermentation also, and sometimes without it, reverts into gross bodies. All bodies, beasts, fishes, insects, plants, &c. with all their various parts, grow and increase out of water and aqueous and saline tinctures; and, by putrefaction, all of them revert into water, or an aqueous liquor again.

TRANSMUTATION, in alchemy, denotes the act of changing imperfect metals into gold or silver. This is also called the *grand operation*; and, they say, it is to be effected with the philosopher's stone.

The trick of transmuting cinnabar into silver is thus: the cinnabar, being bruised grossly, is stratified in a crucible with granulated silver, and the crucible placed in a great fire; and, after due time for calcination, taken off; then the matter, being poured out, is found to be cinnabar

cinnabar turned into real silver, though the silver grains appear in the same number and form as when they were put into the crucible; but the mischief is, coming to handle the grains of silver, you find them nothing but light friable bladders which will crumble to pieces between the fingers.

The transmutability of water into earth seems to have been believed by Mr Boyle; and Bishop Watson thinks that it has not yet been disproved. See his *Chemical Essays*.

Transmutation of Acids, or *of Metals*, is the change of one acid or of one metal into another.

TRANSOM, among builders, denotes the piece that is framed across a double-light window.

TRANSOMS, in a ship, certain beams or timbers extended across the sternpost of a ship, to fortify her afterpart, and give it the figure most suitable to the service for which she is calculated.

TRANSPARENCY, in *Physics*, a quality in certain bodies, whereby they give passage to the rays of light: in contradistinction to opacity, or that quality of bodies which renders them impervious to the rays of light.

It has been generally supposed by philosophers, that transparent bodies have their pores disposed in straight lines, by which means the rays of light have an opportunity of penetrating them in all directions; but some experiments in electricity have made it apparent, that by the action of this fluid the most opaque bodies, such as sulphur, pitch, and sealing-wax, may be rendered transparent as glass, while yet we cannot suppose the direction of their pores to be any way altered from what it originally was (see Electricity). There is a curious instance of an increase of transparency in rubbing a piece of white paper over one that has been written upon or printed: while the white paper is at rest, the writing or print will perhaps scarce appear through it; but when in motion, will be very easily legible, and continue so till the motion is discontinued.

TRANSPOSITION, in *Grammar*, a disturbing or dislocating the words of a discourse, or a changing their natural order of construction, to please the ear by rendering the contexture more smooth, easy, and harmonious.

TRANSUBSTANTIATION, in *Theology*, the conversion or change of the substance of the bread and wine in the eucharist, into the body and blood of Jesus Christ; which the Romish church suppose to be wrought by the consecration of the priest. See *Supper of the Lord*, N° 5.

TRANSVERSALIS, in *Anatomy*, a name given to several muscles. See Anatomy, Part II.

TRANSVERSE, something that goes across another from corner to corner: thus bends and bars in heraldry are transverse pieces or bearings; the diagonals of a parallelogram or a square are transverse lines.

TRANSYLVANIA, a province of Europe, annexed to Hungary, and bounded on the north by Upper Hungary and Galicia, on the east by Moldavia and Walachia, on the south by Walachia, and on the west by Upper and Lower Hungary. It is surrounded on all parts by high mountains, and covers an area of 21,000 square English miles. The inhabitants have abundance of corn and wine; and there are rich mines of gold, silver, lead, copper, quicksilver, and alum. It has undergone various revolutions; but it now belongs to the house of Austria. The inhabitants are of several sorts of religions; as Papists, Lutherans, Calvinists, Socinians, Photinians, Arians, Greeks, and Mahometans. It is about 162 miles in length, and 150 in breadth. The administration of affairs is conducted by twelve persons; namely, three Roman Catholics, three Lutherans, three Calvinists, and three Socinians. The militia is commanded by the governor, whose commission is the more important, as Transylvania is the bulwark of Christendom. It is divided into several small districts, called *palatinates* and *counties*; and its inhabitants, who consist of Saxons, Silesians, and Hungarians, amounted to 1,655,400 in 1805. Hermanstadt is the capital town.

TRAPEZIUM, in *Geometry*, a plane figure contained under four unequal right lines.

TRAPEZIUS, a muscle. See Anatomy, Part II.

TRAPP, a compound rock. See Geology.

TRAVELLERS joy. See Clematis, Botany *Index*.

TRAVERSE, or Transverse, in general, denotes something that goes athwart another; that is, crosses and cuts it obliquely.

Traverse, in *Navigation*, implies a compound course, or an assemblage of various courses, lying at different angles with the meridian. See Navigation.

Traverse Board, a thin circular piece of board, marked with all the points of the compass, and having eight holes bored in each, and eight small pegs hanging from the centre of the board. It is used to determine the different courses run by a ship during the period of the watch, and to ascertain the distance of each course.

TRAVESTY, a name given to a humorous translation of any author. The word is derived from the French *travester*, "to disguise."

TREACLE, or Melasses. See Sugar.

Treacle Beer. See Spruce.

Treacle Mustard. See Clypeola, Botany *Index*.

TREASON, a general appellation, made use of by the law, to denote not only offences against the king and government, but also that accumulation of guilt which arises whenever a superior reposes a confidence in a subject or inferior, between whom and himself there subsists a natural, a civil, or even a spiritual relation; and the inferior so abuses that confidence, so forgets the obligations of duty, subjection, and allegiance, as to destroy the life of any such superior or lord. Hence treason is of two kinds, *high* and *petty*.

High Treason, or *Treason Paramount* (which is equivalent to the *crimen læsæ majestatis* of the Romans, as Glanvil denominates it also in our English law), is an offence committed against the security of the king or kingdom, whether by imagination, word, or deed. In order to prevent the inconveniences which arose in England from a multitude of constructive treasons, the statute 25 Edw. III. c. 2. was made; which defines what offences only for the future should be held to be treason; and this statute comprehends all kinds of high-treason under seven distinct branches.

"1. When a man doth compass or imagine the death of our lord the king, of our lady his queen, or of their eldest son and heir." Under this description it is held that a queen-regnant (such as Queen Elizabeth and

Treason. Queen Anne) is within the words of the act, being invested with royal power, and intitled to the allegiance of her subjects: but the husband of such a queen is not comprised within these words; and therefore no treason can be committed against him.

Let us next see what is a *compassing* or *imagining* the death of the king, &c. These are synonymous terms: the word *compass* signifying the purpose or design of the mind or will; and not, as in common speech, the carrying such design to effect. And therefore an accidental stroke, which may mortally wound the sovereign, *per infortunium*, without any traitorous intent, is no treason: as was the case of Sir Walter Tyrrel, who, by the command of King William Rufus, shooting at a hart, the arrow glanced against a tree, and killed the king upon the spot. But as this compassing or imagination is an act of the mind, it cannot possibly fall under any judicial cognizance, unless it be demonstrated by some open or overt act. The statute expressly requires, that the accused "be thereof upon sufficient proof attainted of some open act by men of his own condition." Thus, to provide weapons or ammunition for the purpose of killing the king, is held to be a palpable overt act of treason in imagining his death. To conspire to imprison the king by force, and move towards it by assembling company, is an overt act of compassing the king's death; for all force used to the person of the king, in its consequence may tend to his death, and is a strong presumption of something worse intended than the present force, by such as have so far thrown off their bounden duty to their sovereign: it being an old observation, that there is generally but a short interval between the prisons and the graves of princes. It seems clearly to be agreed, that by the common law and the statute of Edw. III. words spoken amount only to a high misdemeanor, and no treason. For they may be spoken in heat, without any intention; or be mistaken, perverted, or misremembered by the hearers; their meaning depends always on their connection with other words and things; they may signify differently even according to the tone of voice with which they are delivered; and sometimes silence itself is more expressive than any discourse. As therefore there can be nothing more equivocal and ambiguous than words, it would indeed be unreasonable to make them amount to high treason. And accordingly, in 4 Car. I. on a reference to all the judges, concerning some very atrocious words spoken by one Pyne, they certified to the king, "that though the words were as wicked as might be, yet they were no treason; for unless it be by some particular statute, no words will be treason." If the words be set down in writing, it argues more deliberate intention; and it has been held, that writing is an overt act of treason; for *scribere est agere*. But even in this case the bare words are not the treason, but the deliberate act of writing them.

2. The second species of treason is, "if a man do violate the king's companion, or the king's eldest daughter unmarried, or the wife of the king's eldest son and heir." By the king's companion is meant his wife; and by violation is understood carnal knowledge, as well without force as with it: and this is high treason in both parties if both be consenting; as some of the wives of Henry VIII. by fatal experience evinced.

3. The third species of treason is, "if a man do levy war against our lord the king in his realm." And this may be done by taking arms, not only to dethrone the king, but under pretence to reform religion, or the laws, or to remove evil counsellors, or other grievances whether real or pretended. For the law does not, neither can it permit any private man, or set of men, to interfere forcibly in matters of such high importance; especially as it has established a sufficient power for these purposes in the high court of parliament: neither does the constitution justify any private or particular resistance for private or particular grievances; though, in cases of national oppression, the nation has very justifiably risen as one man, to vindicate the original contract subsisting between the king and his people.

4. "If a man be adherent to the king's enemies in his realm, giving to them aid and comfort in the realm or elsewhere," he is also declared guilty of high-treason. This must likewise be proved by some overt act; as by giving them intelligence, by sending them provisions, by selling them arms, by treacherously surrendering a fortress, or the like.

5. "If a man counterfeit the king's great or privy seal," this is also high-treason. But if a man takes wax bearing the impression of the great seal off from one patent, and fixes it to another, this is held to be only an abuse of the seal, and not a counterfeiting of it: as was the case of a certain chaplain, who in such a manner framed a dispensation for non-residence. But the knavish artifice of a lawyer much exceeded this of the divine. One of the clerks in chancery glued together two pieces of parchment; on the uppermost of which he wrote a patent, to which he regularly obtained the great seal, the label going through both the skins. He then dissolved the cement, and taking off the written patent, on the blank skin, wrote a fresh patent of a different import from the former, and published it as true. This was held no counterfeiting of the great seal, but only a great misprison; and Sir Edward Coke mentions it with some indignation that the party was living at that day.

6. The sixth species of treason under this statute is, "if a man counterfeit the king's money; and if a man bring false money into the realm counterfeit to the money of England, knowing the money to be false, to merchandise and make payment withal." As to the first branch, counterfeiting the king's money; this is treason, whether the false money be uttered in payment or not. Also if the king's own minters alter the standard or alloy established by law, it is treason. But gold and silver money only are held to be within this statute. With regard likewise to the second branch, importing foreign counterfeit money in order to utter it here; it is held that uttering it, without importing it, is not within the statute.

7. The last species of treason ascertained by this statute is, "if a man slay the chancellor, treasurer, or the king's justices of the one bench or the other, justices in eyre, or justices of assize, and all other justices assigned to hear and determine, being in their places doing their offices." These high magistrates, as they represent the king's majesty during the execution of their offices, are therefore for the time equally regarded by the law. But this statute extends only to the actual killing of them; and not to wounding, or a bare attempt to kill them. It extends also only to the officers therein specified; and therefore the barons of the exchequer, as such, are not within

within the protection of this act; but the lord keeper or commissioners of the great seal now seem to be within it, by virtue of the statutes 5 Eliz. c. 18. and 1 W. and M. c. 21.

The new treasons, created since the statute 1 M. c. 1. and not comprehended under the description of statute 25 Edw. III. may be comprised under three heads. The first species relates to Papists; the second to falsifying the coin or other royal signatures, as falsely forging the sign manual, privy signet, or privy seal, which shall be deemed high treason (1 M. stat. ii. c. 6.). The third new species of high treason is such as was created for the security of the Protestant succession in the house of Hanover. For this purpose, after the act of settlement was made, it was enacted by statute 13 and 14 W. III. c. 3. that the pretended prince of Wales, assuming the title of King James III. should be attainted of high treason; and it was made high-treason for any of the king's subjects to hold correspondence with him or any person employed by him, or to remit money for his use. And by 17 Geo. II. c. 39. it is enacted, that if any of the sons of the pretender shall land or attempt to land in this kingdom, or be found in the kingdom or any of its dominions, he shall be adjudged attainted of high-treason; and corresponding with them or remitting money to their use is made high-treason. By 1 Ann. stat. 2. c. 17. the offence of hindering the next in succession from succeeding to the crown is high-treason: and by 6 Ann. c. 7. if any person shall maliciously, advisedly, and directly, by writing or printing, maintain, that any other person hath any right to the crown of this realm, otherwise than according to the act of settlement, or that the kings of this realm with the authority of parliament are not able to make laws to bind the crown and its descent; such person shall be guilty of high-treason.

The punishment of high treason in general is very solemn and terrible. 1. That the offender be drawn to the gallows, and not be carried or walk; though usually (by connivance, at length ripened by humanity into law) a sledge or hurdle is allowed, to preserve the offender from the extreme torment of being dragged on the ground or pavement. 2. That he be hanged by the neck, and then cut down alive. 3. That his entrails be taken out, and burned while he is yet alive. 4. That his head be cut off. 5. That his body be divided into four parts. 6. That his head and quarters be at the king's disposal.

The king may, and often doth, discharge all the punishment except beheading, especially where any of noble blood are attainted. For beheading being part of the judgment, that may be executed, though all the rest be omitted by the king's command. But where beheading is no part of the judgment, as in murder or other felonies, it hath been said that the king cannot change the judgment, although at the request of the party, from one species of death to another.

In the case of coining, which is a treason of a different complexion from the rest, the punishment is milder for male offenders; being only to be drawn and hanged by the neck till dead. But in treasons of every kind the punishment of women is the same, and different from that of men. For as the natural modesty of the sex forbids the exposing and publicly mangling their bodies, their sentence (which is to the full as terrible to sense as the other) is to be drawn to the gallows, and there to be burned alive.

For the consequences of this judgment, see ATTAINDER, FORFEITURE, and *CORRUPTION of Blood*.

Petty or *Petit Treason*, according to the statute 25 Edward III. c. 2. may happen three ways: by a servant killing his master, a wife her husband, or an ecclesiastical person (either secular or regular) his superior, to whom he owes faith and obedience. A servant who kills his master whom he has left, upon a grudge conceived against him during his service, is guilty of petty treason: for the traitorous intention was hatched while the relation subsisted between them, and this is only an execution of that intention. So if a wife be divorced *a mensa et thoro*, still the *vinculum matrimonii* subsists; and if she kills such divorced husband, she is a traitress. And a clergyman is understood to owe canonical obedience to the bishop who ordained him, to him in whose diocese he is beneficed, and also to the metropolitan of such suffragan or diocesan bishop; and therefore to kill any of these is petit treason. As to the rest, whatever has been said with respect to wilful MURDER, is also applicable to the crime of petit treason, which is no other than murder in its most odious degree; except that the trial shall be as in cases of high treason, before the improvements therein made by the statutes of William III. But a person indicted of petit treason may be acquitted thereof, and found guilty of manslaughter or murder: and in such case it should seem that two witnesses are not necessary, as in cases of petit treason they are. Which crime is also distinguished from murder in its punishment.

The punishment of petit treason in a man, is to be drawn and hanged, and in a woman to be drawn and burned: the idea of which latter punishment seems to have been handed down to us from the laws of the ancient Druids, which condemned a woman to be burned for murdering her husband; and it is now the usual punishment for all sorts of treasons committed by those of the female sex. Persons guilty of petit treason were first debarred the benefit of clergy by statute 12 Henry VII. c. 7. which has since been extended to their aiders, abettors, and counsellors, by statutes 23 Henry VIII. c. 1, 4, and 5 P. and M. c. 4.

TREASURE, in general, denotes a store or stock of money in reserve.

TREASURE-Trove, in *Law*, derived from the French word *trover*, "to find," called in Latin *thesaurus inventus*, is where any money or coin, gold, silver, plate, or bullion, is found hidden in the earth or other private place, the owner thereof being unknown; in which case the treasure belongs to the king: but if he that had hid it be known, or afterwards found out, the owner and not the king is intitled to it.

TREASURER, an officer to whom the treasure of a prince or corporation is committed to be kept and duly disposed of, in payment of officers and other expences. See TREASURY.

Of these there is great variety. His majesty of Great Britain, in quality of elector of Hanover, is arch-treasurer of the Roman empire. In England, the principal officers under this denomination are, the lord high-treasurer, the treasurer of the household, treasurer of the navy, of the king's chamber, &c.

The lord high-treasurer of Great Britain, or first commissioner

missioner of the treasury, when in commission, has under his charge and government all the king's revenue which is kept in the exchequer. He holds his place during the king's pleasure; being instituted by the delivery of a white staff to him. He has the check of all the officers employed in collecting the customs and royal revenues: and in his gift and disposition are all the offices of the customs in the several ports of the kingdom; escheators in every county are nominated by him; he also makes leases of the lands belonging to the crown.

The office of lord-treasurer is now in commission. The number of lords-commissioners is five; one of whom is the first lord, whose annual salary was formerly 383l. but is now 4000l.; and who, unless he be a peer, is also chancellor of the exchequer, and prime minister in the government of this country; the other lords commissioners have an annual salary of 1600l. each.

Treasurer of the Household, is an officer who, in the absence of the lord-steward, has power, with the comptroller and other officers of the green-cloth and the steward of the Marshalsea, to hear and determine treasons, felonies, and other crimes committed within the king's palace. See Household.

There is also a treasurer belonging to the establishment of her majesty's household, &c.

Treasurer of the Navy, is an officer who receives money out of the exchequer, by warrant from the lord high-treasurer, or the lords commissioners executing that place; and pays all charges of the navy, by warrant from the principal officers of the navy.

Treasurer of the County, he that keeps the county stock. There are two of them in each county, chosen by the major part of the justices of the peace, &c. at their general quarter session; under previous security given for the money entrusted with them, and the faithful execution of the trusts reposed in them.

TREASURY, the place wherein the revenues of a prince are received, preserved and disbursed. In England the treasury is a part of the exchequer; by some called the *lower exchequer*. The officers of his majesty's treasury, or the lower exchequer, are the lords commissioners, one of whom is chancellor, two joint secretaries, private secretary to the first lord, two chamberlains, an auditor, four tellers, a clerk of the pells, ushers of the receipt, a tally-cutter, &c. See each officer under his proper article, Chancellor, Teller, Tally, &c.

Lords of the Treasury. In lieu of one single director and administrator of his majesty's revenues under the title of *lord high treasurer*, it is at present thought proper to put that office in commission, i. e. to appoint several persons to discharge it with equal authority, under the title of *lords commissioners of the treasury*.

TREATISE, a set discourse in writing on any subject.

TREATY, a covenant between two or more nations; or the several articles or conditions stipulated and agreed upon by two sovereign powers.

TREBLE, in *Music*, the highest or most acute of the four parts in symphony, or that which is heard the clearest and shrillest in a concert.

TREBUCHET, Trebucket, *Tribuch* (*Terbichelum*), a tumbrel or cucking stool. Also a great engine to cast stones to batter walls.

TREE, a large vegetable, rising with one woody stem to a considerable height.

Trees may be divided into two classes, *timber* and *fruit-trees*; the first including all those trees which are used in machinery, ship-building, &c. or, in general, for purposes of utility; and the second comprehending those trees valued only, or chiefly, for their fruit. It is not necessary to form a third class to include trees used for fuel, as timber is used for this purpose where it is abundant; and where it is not abundant the branches of the timber trees, or such of them as are dwarfish, unhealthy, or too small for mechanical purposes, are used as fuel.

The anatomy and physiology of trees have already been given under the generic name Plant and Sap.

Certain trees, it is well known, are natives of particular districts; but many of them have been transplanted from their native soil, and now flourish luxuriantly in distant countries, so that it becomes a matter of very considerable difficulty to ascertain their original soil. The following rules are given for this purpose by the Honourable Daines Barrington.

1. They must grow in large masses, and cover considerable tracts of ground, the woods not ending abruptly, by a change to other trees, except the situation and strata become totally different. 2. They must grow kindly in copses, and shoot from the stool, so as to continue for ever, if not very carefully grubbed up. 3. The seed must ripen kindly; nature never plants but where a succession in the greatest profusion will continue. Lastly, trees that give names to many places are probably indigenous.

The growth of trees is a curious and interesting subject; yet few experiments have been made to determine what the additions are which a tree receives annually in different periods of its age. The only observations which we have seen on this subject worth repeating were made by the ingenious Mr Barker, to whom the Philosophical Transactions are much indebted for papers containing an accurate register of the weather, which he has kept for many years. He has drawn up a table to point out the growth of three kinds of trees, oaks, ashes, and elms; which may be seen in the Philosophical Transactions for 1788. We shall give his conclusions.

"I find (says he) the growth of oak and ash to be nearly the same. I have some of both sorts planted at the same time, and in the same hedges, of which the oaks are the largest; but there is no certain rule as to that. The common growth of an oak or an ash is about an inch in girth in a year; some thriving ones will grow an inch and a half; the unthriving ones not so much. Great trees grow more timber in a year than small ones; for if the annual growth be an inch, a coat of one-sixth of an inch is laid on all round, and the timber added to the body every year is its length multiplied into the thickness of the coat and into the girth, and therefore the thicker the tree is, the more timber is added."

We will present our readers with a table, showing the growth of 17 kinds of trees for two years. The trees grew at Cavenham in Suffolk.

N°	July 1755. F.	In.	July 1786. F.	In.	July 1787. F.	In.
1 Oak	0	$10\frac{1}{8}$	0	$11\frac{1}{8}$	1	$0\frac{1}{2}$
2 Larch	1	$0\frac{1}{8}$	1	3	1	4
3 Scotch fir	1	$3\frac{7}{8}$	1	$5\frac{1}{2}$	1	$7\frac{3}{4}$
4 Spruce fir	0	$5\frac{3}{4}$	0	$6\frac{1}{2}$	0	$7\frac{1}{4}$
5 Spanish chesnut	0	$7\frac{1}{4}$	0	$7\frac{1}{2}$	0	8
6 Elm	2	$7\frac{1}{8}$	2	9	2	11
7 Pinaster	2	$3\frac{1}{2}$	2	$4\frac{1}{2}$	2	$7\frac{1}{2}$
8 Larch	1	$5\frac{1}{4}$	1	6	1	7
9 Weymouth pine	0	5	0	6	0	$7\frac{3}{4}$
10 Acacia	1	$2\frac{3}{4}$	1	$5\frac{3}{4}$	1	$6\frac{1}{2}$
11 Beech	0	$6\frac{1}{4}$	0	$6\frac{1}{2}$	0	$7\frac{1}{4}$
12 Plane, occidental	0	$6\frac{5}{8}$	0	$7\frac{3}{4}$	0	$8\frac{1}{4}$
13 Lombardy poplar	1	8	2	0	2	$3\frac{3}{4}$
14 Black poplar	1	$2\frac{1}{4}$	1	$4\frac{1}{2}$	1	$5\frac{3}{4}$
15 Willow	2	$9\frac{1}{8}$	3	2	3	3
16 Silver fir	0	$7\frac{3}{4}$	0	$8\frac{3}{4}$	0	$9\frac{1}{4}$
17 Lime	1	$8\frac{1}{2}$	1	$10\frac{1}{4}$	2	0

Trees sometimes attain a very great size: this must depend in a great measure on the richness of soil, but no less on the degree of heat. Indeed heat is so essential to the growth of trees, that as we go from the place within the polar circles where vegetation begins, and advance to the equator, we find the trees increase in size. Greenland, Iceland, and other places in the same latitude, yield no trees at all; and the shrubs which they produce are dwarfish; whereas, in warm climates, they often grow to an immense size. Mr Marsham saw spruce and silver firs in the dock-yard in Venice above 40 yards long, and one of 39 yards was 18 inches diameter at the small end. He was informed that they came from Switzerland.

The largest tree in Europe, mentioned by travellers, is the chesnut tree on Mount Etna, already described under the article ETNA, N° 18. It is a certain fact that trees acquire a very great size in volcanic countries. Beside the multitude of fine groves in the neighbourhood of Albano in Italy, there are many detached oaks 20 feet in circumference, and many elms of the same size, especially in the romantic way to Eastello, called the *Galleria*. In travelling by the side of the lake of Bolsena, the road leads through an immense number of oaks, spread upon beautiful hills. Where the lava has been sufficiently softened, they are clean and straight, and of a considerable size; but where the lava has not been converted into a soil proper for strong vegetation, they are round-headed, and of less size; however, taken all together, they make a magnificent appearance; and the spot itself ought to be ranked among the fine parts of Italy. The same may be observed of the small lake of Vico, encompassed with gentle risings, that are all clothed with forest-trees.

Some yews have been found in Britain 60 feet round. Palms in Jamaica attain the height of 200 feet; and some of the pines in Norfolk island are 280 feet high.

Of all the different kinds known in Europe, oak is best for building; and even when it lies exposed to air and water, there is none equal to it. Fir timber is the next in degree of goodness for building, especially in England, where they build upon leases. It differs from oak in this, that it requires not much seasoning, and therefore no great stock is required before-hand. Fir is used for flooring, wainscoting, and the ornamental parts of building within doors. Elm is the next in use, especially in England and France: it is very tough and pliable, and therefore easily worked: it does not readily split; and it bears driving of bolts and nails better than any other wood; for which reason it is chiefly used by wheel-wrights and coach-makers, for shafts, naves, &c. Beech is also used for many purposes: it is very tough and white when young, and of great strength; but liable to warp very much when exposed to the weather, and to be worm eaten when used within doors; its greatest use is for planks, bedsteads, chairs, and other household goods. Ash is likewise a very useful wood, but very scarce in most parts of Europe; it serves in buildings, or for any other use, when screened from the weather; handspikes and oars are chiefly made of it. Wild chesnut timber is by many esteemed to be as good as oak, and seems to have been much used in old buildings; but whether these trees are more scarce at present than formerly, or have been found not to answer so well as was imagined, it is certain that this timber is now but little used. Walnut-tree is excellent for the joiner's use, it being of a more curious brown colour than beech, and not so subject to the worms. The poplar, abele, and aspen trees, which are very little different from each other, are much used instead of fir; they look well, and are tougher and harder.

The goodness of timber not only depends on the soil and situation in which it stands, but likewise on the season wherein it is felled. In this people disagree very much; some are for having it felled as soon as its fruit is ripe, others in the spring, and many in the autumn. But as the sap and moisture of timber is certainly the cause that it perishes much sooner than it otherwise would do, it seems evident, that timber should be felled when there is the least sap in it, viz. from the time that the leaves begin to fall till the trees begin to bud. This work usually commences about the end of April in England, because the bark then rises most freely; for where a quantity of timber is to be felled, the statute requires it to be done then, for the advantage of tanning. The ancients chiefly regarded the age of the moon in felling their timber; their rule was to fell it in the wane, or four days after the new moon, or sometimes in the last quarter. Pliny advises it to be in the very instant of the change: which happening to be in the last day of the winter solstice, the timber, says he, will be incorruptible.

Timber should likewise be cut when of a proper age; for when it is either too young or too old, it will not be so durable as when cut at a proper age. It is said that oak should not be cut under 60 years old, nor above 200. Timber, however, should be cut in its prime, when almost fully grown, and before it begins to decay; and this will be sooner or later according to the dryness and moistness of the soil where the timber grows, as also according to the bigness of the trees; for there are no fixed rules in felling of timber, experience and judgment must direct here as in most other cases.

Great attention is necessary in the seasoning of tim-

Tree. ber. Some advise the planks of timber to be laid for a few days in some pool or running stream, in order to extract the sap, and afterwards to dry them in the sun or air. By this means, it is said, they will be prevented from either chopping, casting, or cleaving; but against shrinking there is no remedy. Some again are for burying them in the earth, others in a heat; and some for scorching and seasoning them in fire, especially piles, posts, &c. which are to stand in water or earth. The Venetians first found out the method of seasoning by fire; which is done after this manner: They put the piece to be seasoned into a strong and violent flame; in this they continually turn it round by means of an engine, and take it out when it is everywhere covered with a black coaly crust; the internal part of the wood is thereby so hardened, that neither earth nor water can damage it for a long time afterwards.

Dr Plott says, it is found by long experience, that the trunk or body of the trees, when barked in the spring, and left standing naked all the summer exposed to the sun and wind, are so dried and hardened, that the sappy part in a manner becomes as firm and durable as the heart itself. This is confirmed by M. Buffon, who, in 1738, presented to the Royal Academy of Sciences at Paris a memoir entitled, "An easy method of increasing the solidity, strength, and duration of timber;" for which purpose he observes, "nothing more is necessary than to strip the tree entirely of its bark during the season of the rising of the sap, and to leave it to dry completely before it be cut down."

By many experiments, particularly described in that essay, it appears, that the tree should not be felled till the third year after it has been stripped of the bark; that it is then perfectly dry, and the sap become almost as strong as the rest of the timber, and stronger than the heart of any other oak tree which has not been so stripped; and the whole of the timber stronger, heavier, and harder; from which he thinks it fair to conclude, that it is also more durable. "It would no longer (he adds) be necessary, if this method were practised, to cut off the sap; the whole of the tree might be used as timber; one of 40 years growth would serve all the purposes for which one of 60 years is now required; and this practice would have the double advantage of increasing the quantity, as well as the strength and solidity, of the timber."

The navy board, in answer to the inquiries of the commissioners of the land revenue, in May 1789, informed them, that they had then standing some trees stripped of their bark two years before, in order to try the experiment of building one half of a sloop of war with that timber, and the other half with timber felled and stripped in the common way. This very judicious mode of making the experiment, if it be properly executed, will undoubtedly go far to ascertain the effects of this practice. We are sorry that we are not able to inform our readers what was the result of the experiment.

After the planks of timber have been well seasoned and fixed in their places, care is to be taken to defend or preserve them; to which the smearing them with linseed oil, tar, or the like oleaginous matter, contributes much. The ancients, particularly Hesiod and Virgil, advise the smoke-drying of all instruments made of wood, by hanging them up in the chimneys where wood fires are used. The Dutch preserve their gates, portcullices, drawbridges, sluices, &c. by coating them over with a mixture of pitch and tar, whereon they strew small pieces of cockle and other shells, beaten almost to powder, and mixed with sea-sand, which incrusts and arms them wonderfully against all assaults of wind and weather. When timber is felled before the sap is perfectly at rest, it is very subject to worms; but to prevent and cure this, Mr Evelyn recommends the following remedy as the most approved: Put common sulphur into a cucurbit, with as much aquafortis as will cover it three fingers deep; distil it to dryness, which is performed by two or three rectifications. Lay the sulphur that remains at bottom, being of a blackish or sand-red colour, on a marble, or put it in a glass, and it will dissolve into an oil; with this oil anoint the timber which is infected with worms. This, he says, will not only prevent worms, but preserve all kinds of woods, and many other things, as ropes, nets, and masts, from putrefaction, either in water, air, or snow.

An experiment to determine the comparative durability of different kinds of timber, when exposed to the weather, was made by a nobleman in Norfolk; of which an account is given by Sir Thomas Beevor. This nobleman, in the year 1774, ordered three posts, forming two sides of a quadrangle, to be fixed in the earth on a rising ground in his park. Into these posts were mortised planks, an inch and a half thick, cut out of trees from 30 to 45 years growth. These, after standing 10 years, were examined, and found in the following state and condition: Annals of Agriculture, vol. ii. p. 156.

The cedar was perfectly sound; larch, the heart sound, but the sap quite decayed; spruce fir, sound; silver fir, in decay; Scotch fir, much decayed; pinaster, quite rotten; chesnut, perfectly sound; abele, sound; beech, sound; walnut, in decay; sycamore, much decayed; birch, quite rotten. Sir Thomas Beevor justly remarks, that the trees ought to have been of the same age; and Mr Arthur Young adds, they ought to have been cut out of the same plantation.

The immense quantity of timber consumed of late years in ship-building and other purposes has diminished in a very great degree the quantity produced in this country. On this account, many gentlemen who wish well to their country, alarmed with the fear of a scarcity, have strongly recommended it to government to pay some attention to the cultivation and preservation of timber.

We find, on the best authority, that of Mr Irving inspector general of imports and exports, that the shipping of England in 1760 amounted to 6107 in number, the tonnage being 433,922; and the shipping in Scotland amounted to 976 in number, the tonnage being 52,818. In 1788 the whole shipping of Britain and Ireland and their colonies amounted to 13,800, being 1,359,752 tons burden, and employing 107,925 men. The tonnage of the royal navy in the same year was 413,667. We are informed also, on what we consider as the best authority (the report of the commissioners of the land revenue), that the quantity of oak timber, of English growth, delivered into the dockyards from 1760 to 1788 was no less than 768,676 loads, and that the quantity used in the merchants yards in the same time was 516,630 loads; in all 1,285,306 loads. The foreign oak used in the same period was only 137,766 loads. Eleventh Report.

Tree. loads. So that, after deducting the quantity remaining in the dock-yards in 1760 and 1788, and the foreign oak, there will remain about 1,054,284 loads of English oak, consumed in 28 years, which is at an average 37,653 loads per annum, besides from 8300 to 10,000 loads expended annually by the East India Company within the same period (A).

The price of wood has risen in proportion to the demand and to its diminution. At the conquest, woods were valued, not by the quantity of timber which they contained, but the number of swine which the acorns could support. In 1608, oak in the forests was sold at 10s. per load, and fir-wood for 2s. per load. In 1663 or 1665, in navy contracts from 2l. to 2l. 15s. 6d. per load was given. In 1756 it rose to 4l. 5s. per load, and 3s. in addition, because no tops are received. Plank four inch sold in 1769 for 7l. a load, three inch 6l.; which prices were the same in 1792.

So great an expenditure of valuable timber within so short a period, gives reason to fear that the forests of this country will soon be entirely dismantled, unless some hing is done to raise fresh supplies. The building of a 70 gun ship, it is said, would take 40 acres of timber. This calculation is indeed so excessive, that it is scarcely credible. This, however, is no exaggeration. According to the prevailing opinion of experienced surveyors, it will require a good soil and good management to produce 40 trees on an acre, which, in a hundred years, may, at an average, be computed at two loads each. Reckoning, therefore, two loads at 8l. 16s. one acre will be worth 350l. and consequently 40 acres will only be worth 14,200l. Now a 70 gun ship is generally supposed to cost 70,000l.; and as ships do not last a great many years, the navy continually requires new ships, so that the forests must be stripped in a century or two, unless young trees are planted to supply their place.

Many plans have been proposed for recruiting the forests. Premiums have been held forth to individuals; and it has been proposed that the crown-lands should be set apart for the special purpose of raising timber. With respect to individuals, as they must generally be disposed to sow or plant their lands with those vegetables which will best reward their labours, it is not to be expected that they will set apart their fields for planting trees unless they have a greater return from them than other crops. But bad must that land be which will not yield much more than 350l. produce in 100 years. But though it be evident that good land will produce crops much more lucrative to the proprietor than timber, yet still there are lands or pieces of land which might be applied with very great advantage to the production of wood. Uneven ground, or the sides of fields where corn cannot be cultivated, might very properly be set apart for this purpose; barren lands, or such as cannot be cultivated without great labour and expence, might also be planted. Hedge-rows and clumps of trees, and little woods scattered up and down, would shelter and defend the fields from destructive winds, would beautify the face of the country, render the climate warmer, improve barren lands, and furnish wood for the arts and manufactures.

But to cultivate forest timber has also been thought of such national importance, that it has been deemed worthy of the attention of government. It has been proposed to appropriate such part of the crown lands as are fit for the purpose solely of producing timber for the navy. This appears a very proper scheme in speculation; but it has been objected, that for government to attempt the farming of forests would be really to establish groups of officers to pocket salaries for doing what, it is well known, will never be done at all. But to this objection we reply, that such an agreement might be made with the inspectors of forests, as to make it their own interest to cultivate trees with as much care as possible. Their salary might be fixed very low, and raised in proportion to the number of trees which they could furnish of such a size in a certain number of years. After all, we must acknowledge that we must depend greatly on Russia, Sweden, Norway, and America, for supplying us with timber; and while these countries take our manufactures in exchange, we have no reason to complain. Still, however, we ought surely not to neglect the cultivation of what is of so much importance to our existence as a nation, for it may often be impossible in time of war to obtain timber from foreign countries.

In the beginning of this article we mentioned the general division of trees into timber or forest-trees and fruit trees. We have already said all that our limits will permit respecting the former: we will now, therefore, say something of the latter. Our observations shall be confined to the methods of preserving fruit trees in blossom from the effects of frost, and from other diseases to which they are liable.

The Chevalier de Dienenberg of Prague, we are told, has discovered a method of effectually preserving trees in blossom from the fatal effects of those frosts which sometimes in the spring destroy the most promising hopes of a plentiful crop of fruit. His method is extremely simple. He surrounds the trunk of the tree in blossom with a wisp of straw or hemp. The end of this he sinks, by means of a stone tied to it, in a vessel of spring water, at a little distance from the tree. One vessel will conveniently serve two trees: or the cord may be lengthened so as to surround several, before its end is plunged into the water. It is necessary that the vessel be placed in an open situation, and by no means shaded by the branches of the neighbouring trees, that the frost may produce all its effect on the water, by means of the cord communicating with it.—This precaution is particularly necessary for those trees the flowers of which appear nearly at the same time as the leaves; which trees are peculiarly exposed to the ravages of the frost. The proofs of its efficacy, which he had an opportunity of observing in the spring

European Magazine, March 1791.

(A) A writer in the Bath Transactions says, that the aggregate of oaks felled in England and Wales for 30 years past has amounted to 320,000 loads a year; and affirms that he has documents in his possession founded on indisputable facts. The difference between this account, and that which we have given in the text from the report of the commissioners, we leave to be reconciled by those who have proper opportunities. We give the facts merely on the authority of others.

Tree.

spring of 1787, were remarkably striking. Seven apricot espaliers in his garden began to blossom in the month of March. Fearing that they would suffer from the late frosts, he surrounded them with cords as above directed. In effect, pretty sharp frosts took place six or eight nights: the apricot-trees in the neighbouring gardens were all frozen, and none of them produced any fruit, whilst each of the chevalier's produced fruit in abundance, which came to the greatest perfection.

The following is the method proposed by Mr William Forsyth for curing injuries and defects in trees; for which a reward was given to him by his majesty, on condition that he should make it public. It is equally applicable to forest as to fruit trees (B).

Take one bushel of fresh cow-dung; half a bushel of lime rubbish of old buildings (that from the ceilings of rooms is preferable); half a bushel of wood ashes; and a sixteenth part of a bushel of pit or river sand. The three last articles are to be sifted fine before they are mixed; then work them well together with a spade, and afterwards with a wooden beater, until the stuff is very smooth, like fine plaster used for the ceilings of rooms. The composition being thus made, care must be taken to prepare the tree properly for its application, by cutting away all the dead, decayed, and injured parts, till you come to the fresh sound wood, leaving the surface of the wood very smooth, and rounding off the edges of the bark with a draw-knife, or other instrument, perfectly smooth, which must be particularly attended to. Then lay on the plaster about one-eighth of an inch thick all over the part where the wood or bark has been so cut away, finishing off the edges as thin as possible. Then take a quantity of dry powder of wood ashes, mixed with a sixth part of the same quantity of the ashes of burnt bones; put it into a tin box, with holes in the top, and shake the powder on the surface of the plaster, till the whole is covered over with it, letting it remain for half an hour to absorb the moisture: then apply more powder, rubbing it on gently with the hand, and repeating the application of the powder, till the whole plaster becomes a dry smooth surface.

All trees cut down near the ground should have the surface made quite smooth, rounding it off in a small degree, as before mentioned; and the dry powder directed to be used afterwards should have an equal quantity of powder of alabaster mixed with it, in order the better to resist the dripping of trees and heavy rains. If any of the composition be left for a future occasion, it should be kept in a tub or other vessel, and urine of any kind poured on it, so as to cover the surface; otherwise the atmosphere will greatly hurt the efficacy of the application. Where lime rubbish of old buildings cannot be easily got, take powdered chalk, or common lime, after having been slaked a month at least. As the growth of the tree will gradually affect the plaster, by raising up its edges next the bark, care should be taken, where that happens, to rub it over with the finger when occasion may require (which is best done when moistened by rain), that the plaster may be kept whole, to prevent the air and wet from penetrating into the wound.

Tree || Trent.

Forsyth's Observations on the Diseases of Trees.

By this process, some old worn-out pear trees, that bore only a few small, hard fruit, of a kernelly texture, were made to produce pears of the best quality and finest flavour the second summer after the operation; and in four or five years they bore such plenteous crops, as a young healthy tree would not have produced in four times that period.

By this process, too, some large ancient elms, in a most decayed state, having all their upper parts broken, and a small portion only of the bark remaining, shot out stems from their tops, above thirty feet in height, in six or seven years from the first application of the composition.

Thus may valuable trees be renovated; and forest trees, which are useful or ornamental from their particular situation, be preserved in a flourishing state. But what is far more interesting, a perfect cure has been made, and sound timber produced, in oak trees, which had received very considerable damage from blows, bruises, cutting of deep letters, the rubbing off the bark by the ends of rollers, or wheels of carts, or from the breaking of branches by storms.

TREFOIL. See Trifolium, Botany *Index*.

TREMELLA, a genus of plants belonging to the class of cryptogamia. See Botany *Index*.

TREMOR, an involuntary shaking, chiefly of the hands and head, sometimes of the feet, and sometimes of the tongue and heart.—Tremors arising from a too free use of spirituous liquors require the same treatment as palsies.

TRENCHES, in fortification, are ditches cut by the besiegers, that they may approach the more securely to the place attacked, whence they are also called *lines of approach*.

TRENT, Bishopric of, a province of Germany, in the circle of Austria, near the frontiers of Italy; is bounded on the north by Tirol; on the east by the Feltrino and Bellunese; on the south, by Vincentino, the Veronese, Bresciano, and the lake de Garda; and on the west, by the Bresciano, and the lake de Garda. The soil is said to be very fruitful, and to abound in wine and oil. It is subject to Austria.

Trent, a city of Germany, and capital of the bishopric of that name, is a very ancient place, and stands in a fertile and pleasant plain, in the midst of the high mountains of the Alps. The river Adige washes its walls, and creeping for some time among the hills, runs swiftly into Italy. Trent has three considerable churches, the principal of which is the cathedral: this is a very regular piece of architecture. The church of St Maria Major is all of red and white marble; and is remarkable for being the place where the famous council of Trent

(B) A paste for covering the wounds of trees, and the place where grafts are inserted, was discovered long ago. It is recommended in a Treatise on Fruit Trees, published by Thomas Hitt in 1755; a third edition of which, with additions, was published in 1768. It consists of a mixture of clay and cow's dung diluted with water. This paste he directs to be laid on the wound with a brush; it adheres firmly, he says, without cracking, till the wound heals. We are informed by a gentleman, to whose opinion and experience we pay great respect, that this paste answers every purpose which Mr Forsyth's can serve.

Trent was held, whose decisions are now the standing rule of the Romish church. E. Long. 11. 5. N. Lat. 46.

TRENT, one of the largest rivers in England, which rises in the moorland of Staffordshire, and runs southwest by Newcastle-under-Line; and afterwards dividing the county into two parts, runs to Burton, then to Nottingham and Newark; and so continuing its course due north to Gainsborough on the confines of Lincolnshire, it joins several rivers, and falls into the Humber.

TRENT, *Council of*, in *Ecclesiastical History*, denotes the council assembled by Paul III. in 1545, and continued by 25 sessions till the year 1563, under Julius III. and Pius IV. in order to correct, illustrate, and fix with perspicuity, the doctrine of the church, to restore the vigour of its discipline, and to reform the lives of its ministers. The decrees of this council, together with the creed of Pope Pius IV. contain a summary of the doctrines of the Roman Catholics. These decrees were subscribed by 255 clergy, consisting of four legates, 2 other cardinals, 3 patriarchs, 25 archbishops, 168 bishops, besides inferior clergy. Of these 150 came from Italy, of course the council was entirely under the influence of the pope. For a more particular account of the council of Trent, see Mosheim's Church History, the Modern Universal History, vol. xxiii. and Father Paul's History of the Council of Trent.

TRENTON. See *New Jersey*.

TREPANNING. See SURGERY *Index*.

TRES TABERNÆ, in *Ancient Geography*, a place in Latium, lying on the Via Appia, on the left or south side of the river Astura, to the north of the Paludes Pomptinæ. Its ruins are now seen near Cisterna, a village in the Campagna di Roma, 21 miles from Rome, whence the Christians went out to meet St Paul.

TRESPASS, in *Law*, signifies any transgression of the law, under treason, felony, or misprision of either: but it is commonly used for any wrong or damage that is done by one private person to another, or to the king in his forest.

TRESSLE TREES, in *Ship-Building*, two strong bars of timber fixed horizontally on the opposite sides of the lower mast head, to support the frame of the top and the weight of the top-mast.

TRESSURE, in *Heraldry*, a diminutive of an orle, usually held to be half the breadth thereof.

TRET, in *Commerce*, an allowance made for the waste or the dirt that may be mixed with any commodity; which is commonly four pounds in every 104 pounds weight.

TREVERI, or TREVIRI, in *Ancient Geography*, an ancient and a powerful people, both in horse and foot, according to Cæsar; extending far and wide between the Meuse and the Rhine. Their chief town was called *Treveris*. Now *Triers* or *Treves*.

TREVES, or TRIERS (in Latin *Trevere*, *Trevers*, *Treviris*, or *Augusta Trevirorum*), the capital of the German archbishopric of the same name, stands 60 miles west of Mentz, 52 south of Cologne, and 82 north of Strasburg. This city vies with most in Europe for antiquity, having been a large and noted town before Augustus settled a colony in it. It was free and imperial till the year 1560, when it was surprised and subjected by its archbishop James III. It stands on the Moselle, over which it has a fair stone bridge. The cathedral is a large building; and near it stands the elector's palace. Here are three collegiate and five parish churches, an university founded in 1472, with some remains of the ancient Roman theatre. Roman coins and medals are often found in the ruins of the old city. The private houses here are mean; and the city is neither well fortified nor inhabited. Four-fifths of this archbishopric were seized by France in 1794 and united to her territories; and the remaining parts were secularised and distributed among certain princes in 1802. In 1814 the part which France held was given to Prussia. E. Long. 6. 41. N. Lat. 49. 45.

TRIAL, in *Law*, the examination of a cause according to the laws of the land before a proper judge; or it is the manner and order observed in the hearing and determining of causes.

Trials are either civil or criminal.

I. *Civil Trials.* The species of trials in civil cases are seven: By *record;* by *inspection* or examination; by *certificate;* by *witnesses;* by wager of *battel;* by wager of *law;* and by *jury*. The first six are only had in certain special or eccentrical cases, where the trial by jury would not be so proper or effectual: (See them explained under their respective titles). The nature of the last, that principal criterion of truth in the law of England, shall be explained in this article.

As trial by jury is esteemed one of the most important privileges which members of society can enjoy, and the bulwark of the British constitution, every man of reflection must be stimulated by the desire of inquiring into its origin and history, as well as to be acquainted with the forms and advantages by which it is accompanied. We will therefore begin with tracing it to its origin. Its institution has been ascribed to our Saxon ancestors by Sir William Blackstone.

"Some authors (says that illustrious lawyer) have endeavoured to trace the original of juries up as high as the Britons themselves, the first inhabitants of our island; but certain it is that they were in use among the earliest Saxon colonies, their institution being ascribed by Bishop Nicholson to Woden himself, their great legislator and captain. Hence it is, that we may find traces of juries in the laws of all those nations which adopted the feodal system, as in Germany, France, and Italy; who had all of them a tribunal composed of twelve good men and true, *boni homines*, usually the vassals or tenants of the lord, being the equals or peers of the parties litigant; and, as the lord's vassals judged each other in the lord's courts, so the king's vassals, or the lords themselves, judged each other in the king's court. In England we find actual mention of them so early as the laws of King Ethelred, and that not as a new invention. Stiernhook ascribes the invention of the jury, which in the Teutonic language is denominated *nembda*, to Regner king of Sweden and Denmark, who was contemporary with our King Egbert. Just as we are apt to impute the invention of this, and some other pieces of juridical polity, to the superior genius of Alfred the Great; to whom, on account of his having done much, it is usual to attribute every thing: and as the tradition of ancient Greece placed to the account of their own Hercules whatever achievement was performed superior to the ordinary prowess of mankind. Whereas the truth seems to be, that this tribunal was universally established among all the northern nations, and so interwoven in their very constitution,

Blackst. Comment. vol. iii. p. 349.

constitution, that the earliest accounts of the one give us also some traces of the other."

This opinion has been controverted with much learning and ingenuity by Dr Pettingal in his Inquiry into the Use and Practice of Juries among the Greeks and Romans, who deduces the origin of juries from these ancient nations.

He begins with determining the meaning of the word δικαςαι in the Greek, and *judices* in the Roman, writers. "The common acceptation of these words (says he), and the idea generally annexed to them, is that of *presidents of courts*, or, as we call them, *judges;* as such they are understood by commentators, and rendered by critics. Dr Middleton, in his life of Cicero, expressly calls the judices, *judges of the bench;* and Archbishop Potter, and in short all modern writers upon the Greek or Roman orators, or authors in general, express δικαςαι and *judices* by such terms as convey the idea of *presidents in courts of justice.* The propriety of this is doubted of, and hath given occasion for this inquiry; in which is shown, from the best Greek and Roman authorities, that neither the δικαςαι of the Greeks, or the *judices* of the Romans, ever signified *presidents in courts of judicature*, or *judges of the bench;* but, on the contrary, they were distinguished from each other, and the difference of their duty and function was carefully and clearly pointed out by the orators in their pleadings, who were the best authorities in those cases, where the question related to forms of law, and methods of proceeding in judicial affairs and criminal process.

The presidents of the courts in criminal trials at Athens were the nine archons, or chief magistrates, of which whoever presided was called ηγεμων δικαςηριε, or president of the court. These nine presided in different causes peculiar to each jurisdiction. The archon, properly so called, had belonging to his department all pupillary and heritable cases; the βασιλευς or *rex sacrorum*, the chief priest, all cases where religion was concerned; the polemarchus, or general, the affairs of the army and all military matters; and the six thesmothetæ, the other ordinary suits.

Wherever then the ανδρες δικαςαι, or judicial men, are addressed by the Greek orators in their speeches, they are not to be understood to be the presiding magistrates, but another class of men, who were to inquire into the state of the cause before them, by witnesses and other methods of coming at truth; and after inquiry made and witnesses heard, to report their opinion and verdict to the president, who was to declare it.

The several steps and circumstances attending this judicial proceeding are so similar to the forms observed by our jury, that the learned reader, for such I must suppose him, cannot doubt but that the nature, intent, and proceedings of the δικαςηριοι among the Greeks were the same with the English jury; namely, for the protection of the lower people from the power and oppression of the great, by administering equal law and justice to all ranks; and therefore when the Greek orators directed their speeches to the ανδρες δικαςαι, as we see in Demosthenes, Æschines, and Lysias, we are to understand it in the same sense as when our lawyers at the bar say, *Gentlemen of the jury.*

So likewise among the Romans, the *judices*, in their pleadings at the bar, never signified judges of the bench, or presidents of the court, but a body or order of men, whose office in the courts of judicature was distinct from that of the prætor or *judex questionis*, which answered to our judge of the bench, and was the same with the archon, or ηγεμων δικαςηριε, of the Greeks: whereas the duty of the judices consisted in being impannelled, as we call it, challenged, and swore to try uprightly the case before them; and when they had agreed upon their opinion or verdict, to deliver it to the president who was to pronounce it. This kind of judicial process was first introduced into the Athenian polity by Solon, and thence copied into the Roman republic, as probable means of procuring just judgment, and protecting the lower people from the oppression or arbitrary decisions of their superiors.

When the Romans were settled in Britain as a province, they carried with them their *jura* and *instituta*, their laws and customs, which was a practice essential to all colonies; hence the Britons, and other countries of Germany and Gaul, learned from them the Roman laws and customs; and upon the irruption of the northern nations into the southern kingdoms of Europe, the laws and institutions of the Romans remained, when the power that introduced them was withdrawn: and Montesquieu tells us, that under the first race of kings in France, about the fifth century, the Romans that remained, and the Burgundians their new masters, lived together under the same Roman laws and police, and particularly the same forms of judicature. How reasonable then is it to conclude, that in the Roman courts of judicature continued among the Burgundians, the form of a jury remained in the same state it was used at Rome. It is certain, Montesquieu, speaking of those times, mentions the *paires* or *hommes de fief*, homagers or peers, which in the same chapter he calls *juges, judges* or *jurymen:* so that we hence see how at that times the *hommes de fief*, or "men of the fief," were called *peers*, and those peers were *juges* or jurymen. These were the same as are called in the laws of the Confessor *pers de la tenure*, the "peers of the tenure, or homagers," out of whom the jury of peers were chosen, to try a matter in dispute between the lord and his tenant, or any other point of controversy in the manor. So likewise in all other parts of Europe, where the Roman colonies had been, the Goths succeeding them, continued to make use of the same laws and institutions, which they found to be established there by the first conquerors. This is a much more natural way of accounting for the origin of a jury in Europe, than having recourse to the fabulous story of Woden and his savage Scythian companions, as the first introducers of so humane and beneficent an institution."

Trials by jury in civil causes are of two kinds; *extraordinary* and *ordinary.*

1. The first species of *extraordinary* trial by jury is that of the grand assize, which was instituted by King Henry II. in parliament, by way of alternative offered to the choice of the tenant or defendant in a writ of right, instead of the barbarous and unchristian custom of duelling. For this purpose a writ *de magna assisa eligenda* is directed to the sheriff, to return four knights, who are to elect and choose 12 others to be joined with them; and these all together form the grand assize, or great jury, which is to try the matter of right, and must now consist of 16 jurors. Another species of extraordinary juries is the jury to try an attaint; which is a process commenced against a former jury for bringing a false verdict. See the article ATTAINT.

Trial.

2. With regard to the *ordinary* trial by jury in civil cases, the most clear and perspicuous way of treating it will be by following the order and course of the proceedings themselves.

Blackst Comment.

When therefore an issue is joined by these words, "And this the said A prays may be inquired of by the country;" or, "And of this he puts himself upon the country, and the said B does the like;" the court awards a writ of *venire facias* upon the roll or record, commanding the sheriff "that he cause to come here, on such a day, twelve free and lawful men, *liberes et legales homines*, of the body of his country, by whom the truth of the matter may be better known, and who are neither of kin to the aforesaid A nor the aforesaid B, to recognise the truth of the issue between the said parties." And such writ is accordingly issued to the sheriff. It is made returnable on the last return of the same term wherein issue is joined, viz. hilary or trinity terms; which, from the making up of the issues therein, are usually called *issuable terms*. And he returns the names of the jurors in a panel (a little pane or oblong piece of parchment) annexed to the writ. This jury is not summoned, and therefore not appearing at the day must unavoidably make default. For which reason a compulsive process is now awarded against the jurors, called in the common pleas a writ of *habeas corpora juratorum*, and in the King's Bench *distringas*, commanding the sheriff to have their bodies, or to distrain them by their lands and goods, that they may appear upon the day appointed. The entry therefore on the roll of record is, "That the jury is respited, through defect of the jurors, till the first day of the next term, then to appear at Westminster; unless before that time, viz. on Wednesday the fourth of March, the justices of our lord the king appointed to take assizes in that county shall have come to Oxford, that is, to the place assigned for holding the assizes. Therefore the sheriff is commanded to have their bodies at Westminster on the said first day of next term, or before the said justice of assize, if before that time they come to Oxford, viz. on the fourth of March aforesaid." And as the judges are sure to come and open the circuit commissions on the day mentioned in the writ, the sheriff returns and summons this jury to appear at the assizes: and there the trial is had before the justices of assize and *nisi prius:* among whom (as hath been said*) are usually two of the judges of the courts at Westminster, the whole kingdom being divided into six circuits for this purpose. And thus we may observe, that the trial of common issues, at *nisi prius*, was in its original only a collateral incident to the original business of the justices of assize; though now, by the various revolutions of practice, it is become their principal civil employment; hardly any thing remaining in use of the real assizes but the name.

* See the article *Assize*.

If the sheriff be not an indifferent person, as if he be a party in the suit, or be related by either blood or affinity to either of the parties, he is not then trusted to return the jury; but the *venire* shall be directed to the coroners, who in this, as in many other instances, are the substitutes of the sheriff to execute process when he is deemed an improper person. If any exception lies to the coroners, the *venire* shall be directed to two clerks of the court, or two persons of the county named by the court, and sworn. And these two, who are called *elisors*, or electors, shall indifferently name the jury, and their return is final; no challenge being allowed to their array.

Let us now pause a while, and observe (with Sir Matthew Hale*), in these first preparatory stages of the trial, how admirably this constitution is adapted and framed for the investigation of truth beyond any other method of trial in the world. For, first, the person returning the jurors is a man of some fortune and consequence; that so he may be not only the less tempted to commit wilful errors, but likewise be responsible for the faults of either himself or his officers; and he is also bound by the obligation of an oath faithfully to execute his duty. Next, as to the time of their return: the panel is returned to the court upon the original *venire*, and the jurors are to be summoned and brought in many weeks afterwards to the trial, whereby the parties may have notice of the jurors, and of their sufficiency or insufficiency, characters, connections, and relations, that so they may be challenged upon just cause; while, at the same time, by means of the compulsory process (of *distringas*, or *habeas corpora*) the cause is not liketo be retarded through defect of jurors. Thirdly, As to the place of their appearance: which in causes of weight and consequence is at the bar of the court; but in ordinary cases at the assizes, held in the county where the cause of action arises, and the witnesses and jurors live: a provision most excellently calculated for the saving of expence to the parties. For though the preparation of the causes in point of pleading is transacted at Westminster, whereby the order and uniformity of proceeding is preserved throughout the kingdom, and multiplicity of forms is prevented; yet this is no great charge or trouble, one attorney being able to transact the business of 40 clients. But the troublesome and most expensive attendance is that of jurors and witnesses at the trial; which therefore is brought home to them, in the county where most of them inhabit. Fourthly, The persons before whom they are to appear, and before whom the trial is to be held, are the judges of the superior court, if it be a trial at bar; or the judges of assize, delegated from the courts at Westminster by the king, if the trial be held in the country: persons, whose learning and dignity secure their jurisdiction from contempt, and the novelty and very parade of whose appearance have no small influence upon the multitude. The very point of their being strangers in the county is of infinite service, in preventing those factions and parties which would intrude in every cause of moment, were it tried only before persons resident on the spot, as justices of the peace, and the like. And the better to remove all suspicion of partiality, it was wisely provided by the statutes 4 Edw. III. c. 2. 8 Ric. II. c. 2. and 33 Hen. VIII. c. 24. that no judge of assize should hold pleas in any county wherein he was born or inhabits. And as this institution prevents party and faction from intermingling in the trial of right, so it keeps both the rule and the administration of the laws uniform. These justices, though thus varied and shifted at every assizes, are all sworn to the same laws, have had the same education, have pursued the same studies, converse and consult together, communicate their decisions and resolutions, and preside in those courts which are mutually connected, and their judgments blended together, as they are interchangeably courts of appeal or advice to each other. And hence their administration of justice, and conduct

* *Hist. C. L.* c. 12.

Trial. conduct of trials, are consonant and uniform; whereby that confusion and contrariety are avoided, which would naturally arise from a variety of uncommunicating judges, or from any provincial establishment. But let us now return to the assizes.

When the general day of trial is fixed, the plaintiff or his attorney must bring down the record to the assizes, and enter it with the proper officer, in order to its being called on in course.

These steps being taken, and the cause called on in court, the record is then handed to the judge, to peruse and observe the pleadings, and what issues the parties are to maintain and prove, while the jury is called and sworn. To this end the sheriff returns his compulsive process, the writ of *habeas corpora* or *distringas*, with the panel of jurors annexed, to the judge's officer in court.

The jurors contained in the panel are either special or common jurors. Special juries were originally introduced in trials at bar, when the causes were of too great nicety for the discussion of ordinary freeholders; or where the sheriff was suspected of partiality, though not upon such apparent cause as to warrant an exception to him. He is in such cases, upon motion in court, and a rule granted thereupon, to attend the prothonotary or other proper officer with his freeholder's book; and the officer is to take indifferently 48 of the principal freeholders in the presence of the attorneys on both sides: who are each of them to strike off 12, and the remaining 24 are returned upon the panel. By the statute 3 Geo. II. c. 25. either party is entitled upon motion to have a special jury struck upon the trial of any issue, as well at the assizes as at bar, he paying the extraordinary expence, unless the judge will certify (in pursuance of the statute 24 Geo. II. c. 18.) that the cause required such special jury.

A common jury is one returned by the sheriff according to the directions of the statute 3 Geo. II. c 25. which appoints that the sheriff or officer shall not return a separate panel for every separate cause, as formerly; but one and the same panel for every cause to be tried at the same assizes, containing not less than 48, nor more than 72, jurors: and that their names being written on tickets, shall be put into a box of glass; and when each cause is called, 12 of these persons, whose names shall be first drawn out of the box, shall be sworn upon the jury, unless absent, challenged, or excused; or unless a previous view of the messuages, lands, or place in question, shall have been thought necessary by the court; in which case, six or more of the jurors returned, to be agreed on by the parties, or named by a judge or other proper officer of the court, shall be appointed by special writ of *habeas corpora* or *distringas*, to have the matters in question shown to them by two persons named in the writ; and then such of the jury as have had the view, or so many of them as appear, shall be sworn on the inquest previous to any other jurors. These acts are well calculated to restrain any suspicion of partiality in the sheriff, or any tampering with the jurors when returned.

As the jurors appear when called, they shall be sworn unless challenged by either party. See the article CHALLENGE.

If by means of challenges or other cause, a sufficient number of unexceptionable jurors doth not appear at the trial, either party may pray a *tales*.

5

A *tales* is a supply of such men as are summoned upon the first panel, in order to make up the deficiency. For this purpose a writ of *decem tales*, *octo tales*, and the like, was wont to be issued to the sheriff at common law, and must be still so done at a trial at bar, if the jurors make default. But at the assizes, or *nisi prius*, by virtue of the statute 35 Hen. VIII. c. 6. and other subsequent statutes, the judge is empowered at the prayer of either party to award a *tales de circumstantibus* of persons present in court, to be joined to the other jurors to try the cause; who are liable, however, to the same challenges as the principal jurors. This is usually done till the legal number of 12 be completed; in which patriarchal and apostolical number Sir Edward Coke hath discovered abundance of mystery.

When a sufficient number of persons impannelled, or talesmen appear, they are then separately sworn, well and truly to try the issue between the parties, and a true verdict to give according to the evidence; and hence they are denominated "the jury," *jurata*, and "jurors," *sc. juratores*.

The jury are now ready to hear the merits; and to fix their attention the closer to the facts which they are impannelled and sworn to try, the pleadings are opened to them by counsel on that side which holds the affirmative of the question in issue. For the issue is said to lie, and proof is always first required upon that side which affirms the matter in question: in which our law agrees with the civil, *ei incumbit probatio qui dicit, non qui negat; cum per rerum naturam factum negantis probatio nulla sit.* The opening counsel briefly informs them what has been transacted in the court above; the parties, the nature of the action, the declaration, the plea, replication, and other proceedings; and lastly, upon what point the issue is joined, which is there sent down to be determined. Instead of which, formerly the whole record and process of the pleadings were read to them in English by the court, and the matter of issue clearly explained to their capacities. The nature of the case, and the evidence intended to be produced, are next laid before them by counsel also on the same side; and when their evidence is gone through, the advocate on the other side opens the adverse case, and supports it by evidence; and then the party which began is heard by way of reply. See PLEADINGS.

Evidence in the trial by jury is of two kinds; either that which is given in proof, or that which the jury may receive by their own private knowledge. The former, or *proofs*, (to which in common speech the name of evidence is usually confined) are either written or parol; that is, by word of mouth. Written proofs, or evidence, are, 1. Records; and, 2. Ancient deeds of 30 years standing, which prove themselves: but, 3. Modern deeds; and, 4. Other writings, must be attested and verified by parol evidence of witnesses. With regard to parol evidence or witnesses; it must first be remembered that there is a process to bring them in by writ of *subpœna ad testificandum;* which commands them, laying aside all pretences and excuses, to appear at the trial on pain of 100l. to be forfeited to the king; to which the statute 5 Eliz. c. 9. has added a penalty of 10l. to the party aggrieved, and damages equivalent to the loss sustained by want of his evidence. But no witness, unless his reasonable expences be tendered him is bound to appear at all; nor, if he appear, is he bound to to give evidence till such charges are actually paid him; except he resides within the bills of mortality, and is summoned to give evidence within the same. This compulsory process, to bring in unwilling witnesses, and the additional terrors of an attachment in case of disobedience, are of excellent use in the thorough investigation of truth: and, upon the same principle, in the Athenian courts, the witnesses who were summoned to attend the trial had their choice of three things: either to swear to the truth of the fact in question, to deny or abjure it, or else to pay a fine of 1000 drachmas.

All witnesses, of whatever religion or country, that have the use of their reason, are to be received and examined, except such as are infamous, or such as are interested in the event of the cause. All others are competent witnesses; though the jury from other circumstances will judge of their credibility. Infamous persons are such as may be challenged as jurors, *propter delictum:* and therefore never shall be admitted to give evidence to inform that jury, with whom they were too scandalous to associate. Interested witnesses may be examined upon a *voir dire,* if suspected to be secretly concerned in the event; or their interest may be proved in court. Which last is the only method of supporting an objection to the former class; for no man is to be examined to prove his own infamy. And no counsel, attorney, or other person, intrusted with the secrets of the cause by the party himself, shall be compelled, or perhaps allowed, to give evidence of such conversation or matters of privacy as came to his knowledge by virtue of such trust and confidence: but he may be examined as to mere matters of fact, as the execution of a deed or the like, which might have come to his knowledge without being intrusted in the cause.

One witness (if credible) is sufficient evidence to a jury of any single fact: though undoubtedly the concurrence of two or more corroborates the proof. Yet our law considers that there are many transactions to which only one person is privy; and therefore does not always demand the testimony of two. Positive proof is always required, where, from the nature of the case, it appears it might possibly have been had. But, next to positive proof, circumstantial evidence, or the doctrine of presumptions, must take place: for when the fact itself cannot be demonstratively evinced, that which comes nearest to the proof of the fact is the proof of such circumstances which either necessarily or usually attend such facts; and these are called *presumptions,* which are only to be relied upon till the contrary be actually proved.

The oath administered to the witness is not only that what he deposes shall be true, but that he shall also depose the whole truth: so that he is not to conceal any part of what he knows, whether interrogated particularly to that point or not. And all this evidence is to be given in open court, in the presence of the parties, their attorneys, the counsel, and all bystanders: and before the judge and jury: each party having liberty to except to its competency, which exceptions are publicly stated, and by the judge are openly and publicly allowed or disallowed, in the face of the country: which must curb any secret bias or partiality that might arise in his own breast.

When the evidence is gone through on both sides, the judge, in the presence of the parties, the counsel, and all others, sums up the whole to the jury; omitting all superfluous circumstances, observing wherein the main question and principal issue lies, stating what evidence has been given to support it, with such remarks as he thinks necessary for their direction, and giving them his opinion in matters of law arising upon that evidence.

The jury, after the proofs are summed up, unless the case be very clear, withdraw from the bar to consider of their verdict; and in order to avoid intemperance, and causeless delay, are to be kept without meat, drink, fire, or candle, unless by permission of the judge, till they are unanimously agreed. A method of accelerating unanimity not wholly unknown in other constitutions of Europe, and in matters of greater concern. For by the golden bull of the empire, if, after the congress is opened, the electors delay the election of a king of the Romans for 30 days, they shall be fed only with bread and water till the same is accomplished. But if our juries eat or drink at all, or have any eatables about them, without consent of the court, and before verdict, it is finable; and if they do so at his charge for whom they afterwards find, it will set aside the verdict. Also, if they speak with either of the parties or their agents after they are gone from the bar, or if they receive any fresh evidence in private, or if, to prevent disputes, they cast lots for whom they shall find, any of these circumstances will entirely vitiate the verdict. And it has been held, that if the jurors do not agree in their verdict before the judges are about to leave the town, though they are not to be threatened or imprisoned, the judges are not bound to wait for them, but may carry them round the circuit from town to town in a cart. This necessity of a total unanimity seems to be peculiar to our own constitution; or at least, in the *nembda* or jury of the ancient Goths, there was required (even in criminal cases) only the consent of the major part; and in case of an equality, the defendant was held to be acquitted.

When they are all unanimously agreed, the jury return back to the bar; and before they deliver their verdict, the plaintiff is bound to appear in court, by himself, attorney, or counsel, in order to answer the amercement to which by the old law he is liable, in case he fails in his suit, as a punishment for his false claim. To be amerced, or *a mercie,* is to be at the king's mercy with regard to the fine to be imposed; in *misericordia domini regis pro falso clamore suo.* The amercement is disused, but the form still continues; and if the plaintiff does not appear, no verdict can be given; but the plaintiff is said to be nonsuit, *non sequitur clamorem suum.* Therefore it is usual for a plaintiff, when he or his counsel perceives that he has not given evidence sufficient to maintain his issue, to be voluntarily nonsuited, or withdraw himself: whereupon the crier is ordered to call the plaintiff; and if neither he, nor any body for him, appears, he is nonsuited, the jurors are discharged, the action is at an end, and the defendant shall recover his costs. The reason of this practice is, that a nonsuit is more eligible for the plaintiff than a verdict against him: for after a nonsuit, which is only a default, he may commence the same suit again for the same cause of action; but after a verdict had, and judgment consequent thereupon, he is for ever barred from attacking the

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the defendant upon the same ground of complaint. But in case the plaintiff appears, the jury by their foreman deliver in their verdict.

A verdict, *vere dictum*, is either privy or public. A privy verdict is when the judge hath left or adjourned the court: and the jury, being agreed, in order to be delivered from their confinement, obtain leave to give their verdict privily to the judge out of court: which privy verdict is of no force, unless afterwards affirmed by a public verdict given openly in court; wherein the jury may, if they please, vary from their privy verdict. So that the privy verdict is indeed a mere nullity; and yet it is a dangerous practice, allowing time for the parties to tamper with the jury, and therefore very seldom indulged. But the only effectual and legal verdict is the public verdict: in which they openly declare to have found the issue for the plaintiff, or for the defendant; and if for the plaintiff, they assess the damages also sustained by the plaintiff, in consequence of the injury upon which the action is brought.

When the jury have delivered in their verdict, and it is recorded in court, they are then discharged; and so ends the trial by jury: a trial which ever has been, and it is hoped ever will be, looked upon as the glory of the English law. It is certainly the most transcendant privilege which any subject can enjoy or wish for, that he cannot be affected either in his property, his liberty, or his person, but by the unanimous consent of 12 of his neighbours and equals. A constitution that we may venture to affirm has, under providence, secured the just liberties of this nation for a long succession of ages. And therefore a celebrated French writer *, who concludes, that because Rome, Sparta, and Carthage, have lost their liberties, therefore those of England in time must perish, should have recollected that Rome, Sparta, and Carthage, at the time when their liberties were lost, were strangers to the trial by jury.

* *Montesquieu, Spir. L.* xi. 6.

Great as this eulogium may seem, it is no more than this admirable constitution, when traced to its principles, will be found in sober reason to deserve.

The impartial administration of justice, which secures both our persons and our properties, is the great end of civil society. But if that be entirely entrusted to the magistracy, a select body of men, and those generally selected by the prince or such as enjoy the highest offices in the state, their decisions, in spite of their own natural integrity, will have frequently an involuntary bias towards those of their own rank and dignity: it is not to be expected from human nature, that the few should be always attentive to the interests and good of the many. On the other hand, if the power of judicature were placed at random in the hands of the multitude, their decisions would be wild and capricious, and a new rule of action would be every day established in our courts. It is wisely therefore ordered, that the principles and axioms of law, which are general propositions flowing from abstracted reason, and not accommodated to times or to men, should be deposited in the breasts of the judges, to be occasionally applied to such facts as come properly ascertained before them. For here partiality can have little scope; the law is well known, and is the same for all ranks and degrees: it follows as a regular conclusion from the premises of fact pre-established. But in settling and adjusting a question of fact, when intrusted to any single magistrate, partiality and injustice have an ample field to range in, either by boldly asserting that to be proved which is not so, or more artfully by suppressing some circumstances, stretching and warping others, and distinguishing away the remainder. Here therefore a competent number of sensible and upright jurymen, chosen by lot from among those of the middle rank, will be found the best investigators of truth, and the surest guardians of public justice. For the most powerful individual in the state will be cautious of committing any flagrant invasion of another's right, when he knows that the fact of his oppression must be examined and decided by 12 indifferent men not appointed till the hour of trial; and that when once the fact is ascertained, the law must of course redress it. This therefore preserves in the hands of the people that share which they ought to have in the administration of public justice, and prevents the encroachments of the more powerful and wealthy citizens.

Criminal TRIALS. The regular and ordinary method of proceeding in the courts of criminal jurisdiction may be distributed under 12 general heads, following each other in a progressive order: viz. 1. Arrest; 2. Commitment and bail; 3. Prosecution; 4. Process; 5. Arraignment, and its incidents; 6. Plea, and issue; 7. Trial, and conviction; 8. Clergy; 9. Judgment, and its consequences; 10. Reversal of judgment; 11. Reprieve, or pardon; 12. Execution. See ARREST, COMMITMENT, PRESENTMENT, INDICTMENT, INFORMATION, APPEAL, *PROCESS upon an Indictment*, ARRAIGNMENT, and PLEA; in which articles all the forms which precede the trial are described, and are here enumerated in the proper order.

The several methods of trial and conviction of offenders, established by the laws of England, were formerly more numerous than at present, through the superstition of our Saxon ancestors; who, like other northern nations, were extremely addicted to divination; a character which Tacitus observes of the ancient Germans. They therefore invented a considerable number of methods of purgation or trial, to preserve innocence from the danger of false witnesses, and in consequence of a notion that God would always interpose miraculously to vindicate the guiltless; as, 1. By ORDEAL; 2. By CORSNED; 3. By BATTEL. See these articles.

4. A fourth method is that by the *peers of Great Britain*, in the *Court of* PARLIAMENT; or the *Court of the Lord High* STEWARD, when a peer is capitally indicted; for in case of an appeal, a peer shall be tried by jury. This differs little from the trial *per patriam*, or by jury; except that the peers need not all agree in their verdict; and except also, that no special verdict can be given in the trial of a peer; because the lords of parliament, or the lord high steward (if the trial be had in his court), are judges sufficiently competent of the law that may arise from the fact; but the greater number, consisting of 12 at the least, will conclude, and bind the minority.

The trial by jury, or the country, *per patriam*, is also that trial by the peers of every Briton, which, as the great bulwark of his liberties, is secured to him by the great charter: *nullus liber homo capiatur, vel imprisonetur, aut exulet, aut aliquo alio modo destruatur, nisi per legale judicium parium suorum, vel per legem terræ.*

When therefore a prisoner on his ARRAIGNMENT has pleaded not guilty, and for his trial hath put himself upon

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upon the country, which country the jury are, the sheriff of the county must return a panel of jurors, *liberos et legales homines, de vicineto*; that is, freeholders without just exception, and of the *visne* or neighbourhood; which is interpreted to be of the county where the fact is committed. If the proceedings are before the court of king's bench, there is time allowed between the arraignment and the trial, for a jury to be impanelled by writ of *venire facias* to the sheriff, as in civil causes; and the trial in case of a misdemeanor is had at *nisi prius*, unless it be of such consequence as to merit a trial at bar; which is always invariably had when the prisoner is tried for any capital offence. But, before commissioners of oyer and terminer and gaol-delivery, the sheriff, by virtue of a general precept directed to him beforehand, returns to the court a panel of 48 jurors, to try all felons that may be called upon their trial at that session; and therefore it is there usual to try all felons immediately or soon after their arraignment. But it is not customary, nor agreeable to the general course of proceedings, unless by consent of parties, to try persons indicted of smaller misdemeanors at the same court in which they have pleaded not guilty, or traversed the indictment. But they usually give security to the court to appear at the next assizes or session, and then and there to try the traverse, giving notice to the prosecutor of the same.

In cases of high-treason, whereby corruption of blood may ensue (except treason in counterfeiting the king's coin or seals), or misprision of such treason, it is enacted by statute 7 W. III. c. 3. first, that no person shall be tried for any such treason, except an attempt to assassinate the king, unless the indictment be found within three years after the offence committed: next, that the prisoner shall have a copy of the indictment (which includes the caption), but not the names of the witnesses, five days at least before the trial, that is, upon the true construction of the act, before his arraignment; for then is his time to take any exceptions thereto, by way of plea or demurrer; thirdly, that he shall also have a copy of the panel of jurors two days before his trial: and, lastly, that he shall have the same compulsive process to bring in his witnesses for him, as was usual to compel their appearance against him. And by statute 7 Ann. c. 21. (which did not take place till after the decease of the late pretender) all persons indicted for high-treason, or misprisions thereof, shall have not only a copy of the indictment, but a list of all the witnesses to be produced, and of the jurors impanelled, with their professions and places of abode, delivered to him ten days before the trial, and in the presence of two witnesses, the better to prepare him to make his challenges and defence. And no person indicted for felony is, or (as the law stands) ever can be, entitled to such copies before the time of his trial.

When the trial is called on, the jurors are to be sworn as they appear, to the number of 12, unless they are challenged by the party.

Challenges may here be made, either on the part of the king, or on that of the prisoner; and either to the whole array, or to the separate polls, for the very same reasons that they may be made in civil causes. But in criminal causes, or at least in capital ones, there is, *in favorem vitæ*, allowed to the prisoner an arbitrary and capricious species of challenge, to a certain number of jurors, without showing any cause at all; which is called a *peremptory* challenge; a provision full of that tenderness and humanity to prisoners for which our English laws are justly famous. This is grounded on two reasons. 1. As every one must be sensible what sudden impressions and unaccountable prejudices we are apt to conceive upon the bare looks and gestures of another; and how necessary it is that a prisoner) when put to defend his life) should have a good opinion of his jury, the want of which might totally disconcert him; the law wills not that he should be tried by any one man against whom he has conceived a prejudice, even without being able to assign a reason for such his dislike. 2. Because, upon challenges for cause shown, if the reason assigned prove insufficient to set aside the juror, perhaps the bare questioning his indifference may sometimes provoke a resentment; to prevent all ill consequences from which, the prisoner is still at liberty, if he pleases, peremptorily to set him aside.

The peremptory challenges of the prisoner must, however, have some reasonable boundary; otherwise he might never be tried. This reasonable boundary is settled by the common law to be the number of 35; that is, one under the number of three full juries.

If by reason of challenges or the default of the jurors, a sufficient number cannot be had of the original panel, a tales may be awarded as in civil causes, till the number of 12 is sworn, "well and truly to try, and true deliverance make, between our sovereign lord the king and the prisoner whom they have in charge; and a true verdict to give, according to their evidence."

When the jury is sworn, if it be a cause of any consequence, the INDICTMENT is usually opened, and the evidence marshalled, examined, and enforced by the counsel for the crown or prosecution. But it is a settled rule at common law, that no counsel shall be allowed a prisoner upon his trial upon the general issue, in any capital crime, unless some point of law shall arise proper to be debated. A rule which (however it may be palliated under cover of that noble declaration of the law, when rightly understood, that the judge shall be counsel for the prisoner; that is, shall see that the proceedings against him are legal and strictly regular) seems to be not at all of a piece with the rest of the humane treatment of prisoners by the English law. For upon what face of reason can that assistance be denied to save the life of a man, which yet is allowed him in prosecutions for every petty trespass? Nor indeed is it, strictly speaking, a part of our ancient law; for the Mirrour, having observed the necessity of counsel in civil suits, "who know how to forward and defend the cause by the rules of law, and customs of the realm," immediately afterwards subjoins, "and more necessary are they for defence upon indictments and appeals of felony, than upon other venial causes." And, to say the truth, the judges themselves are so sensible of this defect in our modern practice, that they seldom scruple to allow a prisoner counsel to stand by him at the bar, and to instruct him what questions to ask, or even to ask questions for him, with regard to matters of fact; for as to matters of law arising on the trial, they are entitled to the assistance of counsel. But still this is a matter of too much importance to be left to the good pleasure of any judge, and is worthy the interposition of the legislature; which has shown its inclination to indulge prisoners with this reasonable assistance, by enacting, in statute 7 W. III. c. 3. that persons indicted for such high-treason as works a corruption of the blood or misprisonment thereof (except treason in counterfeiting the king's coins or seals), may make their full defence by counsel, not exceeding two, to be named by the prisoner, and assigned by the court or judge; and this indulgence, by statute 20 Geo. II. c. 30. is extended to parliamentary impeachments for high-treason, which were excepted in the former act.

When the evidence on both sides is closed, the jury cannot be discharged (unless in cases of evident necessity) till they have given in their VERDICT. If they find the prisoner not guilty, he is then for ever quit and discharged of the accusation, except he be appealed of felony within the time limited by law. And upon such his acquittal, or discharge for want of prosecution, he shall be immediately set at large without payment of any fee to the gaoler. But if the jury find him guilty, he is then said to be convicted of the crime whereof he stands indicted. See the article CONVICTION; and subsequent thereto, the article JUDGMENT, ATTAINDER, FORFEITURE, EXECUTION, also *Benefit of* CLERGY, REPRIEVE, PARDON.

TRIAL, in *Scotland*. See *Scots* LAW.

TRIANDRIA, (from τρεις, "three," and ανηρ, "a man or husband)," the name of the third class in Linnæus's sexual system, consisting of plants with hermaphrodite flowers, which have three stamina or male organs.

TRIANGLE, in *Geometry*, a figure of three sides and three angles.

TRIBE, in antiquity, a certain quantity or number of persons, when a division was made of a city or people into quarters or districts.

TRIBRACHYS, in *Ancient Poetry*, a foot consisting of three syllables, and these all short; as, *melius*.

TRIBUNAL, in general, denotes the seat of a judge, called in our courts *bench*.

TRIBUNE, among the ancient Romans, a magistrate chosen out of the commons, to protect them against the oppressions of the great, and to defend the liberty of the people against the attempts of the senate and consuls.

The tribunes of the people were first established in the year of Rome 259. The first design of their creation was to shelter the people from the cruelty of usurers, and to engage them to quit the Aventine mount, whither they had retired in displeasure.

Their number at first was but two; but the next year, under the consulate of A. Posthumius Aruncius and Cassius Viscellinus, there were three more added; and this number of five was afterwards increased by L. Trebonius to ten.

Military TRIBUNE, an officer in the Roman army, commander in chief over a body of forces, particularly the division of a legion; much the same with our colonel, or the French maitre de camp.

TRIBUTARY, one who pays tribute to another in order to live in peace with or share in his protection.

TRIBUTE, a tax or impost which one prince or state is obliged to pay to another as a token of dependence, or in virtue of a treaty, and as a purchase of peace.

TRICEPS, in *Anatomy*. See there, *Tables of the Muscles*.

TRICHECUS, WALRUS; a genus of aquatic animals belonging to the class of *mammalia*, and order of *bruta*. See MAMMALIA *Index*.

TRICHOMANES, a genus of plants belonging to the class of *cryptogamia*, and order of *filices*. See BOTANY *Index*.

TRICOCCEÆ, (τρεις, "three," and κοκκος, "a grain"), the name of the 38th order in Linnæus's Fragments of a Natural Method, consisting of plants with a single three-cornered capsule, having three cells, or internal divisions, each containing a single seed. See BOTANY.

TRICOSANTHES, a genus of plants belonging to the class of *monœcia*, and in the natural system ranging under the 34th order, *Cucurbitaceæ*. See BOTANY *Index*.

TRIDENT, an attribute of Neptune, being a kind of sceptre which the painters and poets put into the hands of that god, in form of a spear or fork with three teeth; whence the word.

TRIENNIAL, an epithet applied chiefly to offices or employments which last for three years.

TRIENS, in antiquity, a copper money of the value of one third of an *as*, which on one side bore a Janus's head, and on the other a water rat.

TRIENTALIS, CHICKWEED WINTER-GREEN, a genus of plants belonging to the class of *heptandria*, and in the natural system ranging under the 20th order, *Rotaceæ*. See BOTANY *Index*

TRIERS, or TREVES. See TREVES.

TRIFOLIUM, TREFOIL, or *Clover*, a genus of plants belonging to the class of *diadelphia*, and in the natural system ranging under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

TRIGA, in antiquity, denotes a kind of car or chariot drawn by three horses; whence the name.

TRIGLA, a genus of fishes belonging to the order of thoracici. See ICHTHYOLOGY *Index*.

TRIGLOCHIN, a genus of plants belonging to the class of *hexandria*, and in the natural system ranging under the fifth order, *Tripetaloideæ*. See BOTANY *Index*.

TRIGLYPHS, in *Architecture*, a sort of ornament repeated at equal intervals, in the Doric freeze.

Dialing TRIGON. See DIALING.

TRIGONALIS. See PILA.

TRIGONELLA, FENUGREEK, a genus of plants belonging to the class of *diadelphia*, and in the natural system arranged under the 32 order, *Papilionaceæ*. See BOTANY *Index*.

TRIGONOMETRY.

Nature and Construction of Trigonometrical Tables.

TRIGONOMETRY is the application of arithmetic to geometry. It consists of two principal parts, viz. PLANE TRIGONOMETRY and SPHERICAL TRIGONOMETRY.

Plane trigonometry treats of the application of numbers to determine the relations of the sides and angles of a plane triangle to one another.

Spherical trigonometry treats of the application of numbers in like manner to spherical triangles; the nature of these will be explained in the course of this article.

Both branches of the subject depend essentially upon certain numerical tables, the nature and construction of which we shall now proceed to explain.

SECTION I.

NATURE AND CONSTRUCTION OF TRIGONOMETRICAL TABLES.

IT has been demonstrated in GEOMETRY (Theor. 31. Sect. IV). that any angles at the centre of a circle have to one another the same proportion as the arches intercepted between the lines which contain the angles. Hence it is easy to infer, that an angle at the centre of a circle has the same ratio to four right angles, that the arch intercepted between the lines which contain the angle has to the whole circumference. It also follows that we may employ arches of a circle as *measures* of angles, and thus the comparison of angles is reduced to the comparison of arches of a circle. From this principle we infer the consistency of the first of the following series of definitions.

DEFINITIONS.

I. If two straight lines intersect one another in the centre of a circle, the arch of the circumference intercepted between them is called the *Measure* of the angle which they contain. Thus, (Plate DXXXVII. fig. 1.) the arch AB is the measure of the angle contained by the lines CA and CH.

Plate DXXXVII. fig. 1.

II. If the circumference of a circle be divided into 360 equal parts, each of these is called a *Degree;* and if a degree be divided into 60 equal parts, each of these is called a *Minute;* and if a minute be divided into 60 equal parts, each of these is called a *Second*, and so on; and as many degrees, minutes, seconds, &c. as are in any arch, so many degrees, minutes, seconds, &c. are said to be in the angle measured by that arch.

COR. 1. Any arch is to the whole circumference of which it is a part, as the number of degrees and parts of a degree in it is to the number 360. And any angle is to four right angles as the number of degrees, &c. in the arch which is the measure of the angle to 360.

COR. 2. Hence also it appears that the arches which measure the same angle, whatever be the radii with which they are described, contain the same number of degrees and parts of a degree.

Nature and Construction of Trigonometrical Tables.

The degrees, minutes, seconds, &c. contained in an arch or angle are commonly written thus, $23^\circ\ 29'\ 32''\ 20'''$, which expression means 23 degrees 29 minutes 32 seconds, and 20 thirds.

III. Two angles which make together two right angles, also two arches which make together a semicircle, are called the *Supplements* of one another.

IV. A straight line BG drawn through B, one of the extremities of the arch AB, perpendicular to the diameter passing through the other extremity A, is called the *Sine* of the arch AC, or of the angle ACB, having the arch AB for its measure.

COR. 1. The sine of a quadrant or of a right angle is equal to the radius.

COR. 2. The sine of an arch is half the chord of twice the arch.

V. The segment AG of the diameter intercepted between its extremity and the sine BG is called the *Versed Sine* of the arch AB, or of the angle ACB.

VI. A straight line AH touching the circle at A one extremity of the arch AB, and meeting the diameter CB which passes through B the other extremity, is called the *Tangent* of the arch AB, or of the angle ACB.

COR. The tangent of half a right angle is equal to the radius.

VII. The straight line CH between the centre and the extremity of the tangent AH is called the *Secant* of the arch AB or of the angle ACB.

COR. to Def. 4, 6, 7. The sine, tangent, and secant of any angle ACB, are also the sine, tangent, and secant of its supplement BCE. For by the definition, BG is the sine of the angle BCE; and if BC be produced to meet the circle in I, then AH is the tangent and CH the secant of the angle ACI or BCE.

COR. to Def. 4, 5, 6, 7. The sine, versed sine, tangent, and secant of an arch which is the measure of the angle ACB is to the sine, versed sine, and secant of any other arch which is the measure of the same angle, as the radius of the first arch is to the radius of the second.

Let BG, fig. 2. be the sine, AG the versed sine, AH the tangent, and CH the secant of the arch AB to the radius CA; and bg, ag, ah, ch the same things to the radius Ca. From similar triangles BG : bg :: BC : bC; and because CG : Cg (:: CB : Cb) :: CA : Ca; therefore, by division AG : ag :: CA : Ca. Also AH : ah :: CH : Ch :: CA : Ca.

Hence it appears that if tables be constructed exhibiting in numbers the sines, tangents, and versed sines of certain angles to a given radius, they will exhibit the ratios of the sines, tangents, and versed sines of the same angles to any radius whatever. In such tables, which are called trigonometrical tables, the radius is either supposed 1, or some number in the series 10, 100, 1000, &c.

Nature and Construction of Trigonometrical Tables.

&c. The construction and use of these tables we shall presently explain.

VIII. The difference between any angle and a right angle, or between any arch and a quadrant, is called the *Complement* of that angle, or of that arch. Thus, if the angle ACD, fig. 1. be a right angle, and consequently the arch AD, which is its measure, a quadrant, the angle BCD is the complement of the angle BCA, and the arch BD is the complement of the arch AB. Also the complement of the obtuse angle BCE is BCD, its excess above a right angle; and the complement of the arch BDE is the arch BD.

Fig. 1.

IX. The sine, tangent, or secant of the complement of any angle is called the cosine, cotangent, or cosecant of that angle. Thus, supposing the angle ACD to be a right angle, then BF=CG, the sine of the angle BCD, is the cosine of the angle BCA; DK, the tangent of the angle BCD, is the cotangent of the angle BCA, and CK, the secant of the angle BCD, is the cosecant of the angle BCA.

The following properties of the lines which have been defined flow immediately from their position.

1. The sum of the squares of the sine and cosine of any angle is equal to the square of the radius. For, in the right-angled triangle BGC, $BC^2=BG^2+GC^2$, (GEOMETRY, Sect. IV. theor. 13.). Now BG is the sine, and CG=BF is the cosine of the angle BCA.

2. The radius is a mean proportional between the tangent of any angle and its cotangent, or $\tan. ACB \times \cot. ACB = \text{rad.}^2$. For since DK, CA are parallel, the angles DKC, HCA are equal; now CDK, CAH are right angles, therefore the triangles CDK, HCA are similar, and therefore AH : AC :: CD or AC : DK, and $AC^2=AH\times DK$.

3. The radius is a mean proportional between the cosine and secant of any angle. Or $\cos. ACB \times \sec. ACB = \text{rad.}^2$. For the triangles CGB, CAH are similar; therefore CG : CB or CA :: CA : CH.

4. The tangent of an arch is a fourth proportional to its cosine, its sign and the radius, or $\tan. ACB = \frac{\sin. ACB}{\cos. ACB}\times \text{rad.}$ For, from similar triangles CG : GB :: CA : AH.

Trigonometrical tables usually exhibit the sines, tangents, and secants of all angles which can be expressed by an exact number of degrees and minutes from 1 minute to 90 degrees, or a right angle. These may be computed in various ways, the most elementary is to caculate them by the help of principles deducible immediately from the elements of geometry.

It has been demonstrated in GEOMETRY, (Sect. V. prob. 22.) that the chord of one-sixth of the circumference, or an arch of 60°, is equal to the radius; therefore, if BD be an arch of 30°, its sine BF will be half the radius (cor. 2. def. 4.). Let us suppose the radius to be expressed by unity, or 1, then $\sin. 30° = \frac{1}{2}$; now since a being put for any arch, $\cos.^2 a + \sin.^2 a = \text{rad.}^2$ (where by $\cos.^2 a$ is meant the square of the number expressing the cosine of the arch a, &c.) and as $\sin.^2 30° = \frac{1}{4}$, therefore $\cos.^2 30° = 1 - \frac{1}{4} = \frac{3}{4}$, &c. $\cos. 30° = \frac{1}{2}\sqrt{3} = .8660254038$.

It has been demonstrated in the arithmetic of sines (ALGEBRA, § 356.) that $2\cos.^2 a = 1 + \cos. 2a$; hence we have the following formula for finding the cosine of an arch, having given the cosine of its double; $\cos. a = \sqrt{\frac{1+\cos. 2a}{2}}$. By this formula from the cosine of 30° we may find that of 15°, and again from cos. 15° we may find cos. 7° 30′, and proceeding in this way we may find the cosines of 3° 45′, 1° 52′ 30″, and so on, till after 11 bisections the cosine of 52″ 44‴ 3^{iv} 45^{v} is found; we may then find the sine of this arch by the formula $\sin. a = \sqrt{(1 - \cos.^2 a)}$. Now, as from the nature of a circle the ratio of an arch to its sine approaches continually to that of equality, when the arch is continually diminished, it follows that the sines of very small arches will be very nearly to one another as the arches themselves: Therefore, as 52″ 44‴ 3^{iv} 45^{v} to 1′ so is the sine of the former arch to the sine of the latter. By performing all the calculations which we have here indicated, it will be found that the sine of 1′ is .0002908882.

It has been shewn in the arithmetic of sines (ALGEBRA, § 355.) that a and b being put for any two arches, $\sin. (a+b) = 2\cos. b \sin. a - \sin. (a-b)$, hence putting 1′ for b, and 1′, 2′, 3′, &c. successively for a, we have,

$$\sin. 2' = 2\cos. 1' \times \sin. 1',$$
$$\sin. 3' = 2\cos. 1' \times \sin. 2' - \sin. 1',$$
$$\sin. 4' = 2\cos. 1' \times \sin. 3' - \sin. 2',$$
&c.

In this way the sines for every minute of the quadrant may be computed, and as the multiplier cos. 1′ remains always the same, the calculation is easy. If instead of 1′, the common difference of the series of arches were any other angle, the very same formula would apply.

The sines, and consequently the cosines of any number of arches being supposed found, their tangents may be found by considering that $\tan. a = \frac{\sin. a}{\cos. a}$; and their secants from the formula $\sec. a = \frac{1}{\cos. a}$.

We have here very briefly indicated the manner of constructing the trigonometrical *canon*, as it is sometimes called. There are, however, various properties of sines, tangents, &c. which greatly facilitate the actual calculation of the numbers: these the reader will find detailed in ALGEBRA, Sect. XXV. which treats expressly of the *Arithmetic of Sines*.

The most expeditious mode of computing the sine or cosine of a single angle is by means of infinite series: The investigation of these is given in FLUXIONS, § 70.; and it is there shewn that if a denote any arch, then, the radius being expressed by 1,

$$\sin. a = a - \frac{a^3}{1\cdot 2\cdot 3} + \frac{a^5}{1\cdot 2\cdot 3\cdot 4\cdot 5} - \text{\&c.}$$
$$\cos. a = 1 - \frac{a^2}{1\cdot 2} + \frac{a^4}{1\cdot 2\cdot 3\cdot 4} - \text{\&c.}$$

To apply these we must have the arch expressed in parts of the radius, which requires that we know the proportion of the diameter of the circle to its circumference, We have investigated this proportion in GEOMETRY. Prop. 6. Sect. vi.; also in FLUXIONS, § 137.; and subsequently in the article entitled SQUARING THE CIRCLE.

From these series others may be found which shall express the tangent and secant. Thus because tan. $a=$

Nature and Construction of Trigonometrical Tables.

$a = \frac{\sin. a}{\cos. a}$, we get, after dividing the series for the sine by that for the consine,

$$\tan. a = a + \frac{a^3}{3} + \frac{2a^5}{15} + \frac{17a^7}{315} + \&c.$$

And in like manner, dividing unity by the series for $\cos. a$, because $\sec. a = \frac{1}{\cos. a}$, we get

$$\sec. a = 1 + \frac{a^2}{2} + \frac{5a^4}{24} + \frac{61a^6}{720} + \&c.$$

We shall conclude what we proposed to say on the construction of the tables, by referring such of our readers as wish for more extensive information on this subject to Dr Hutton's Introduction to his excellent Mathematical Tables; also to the treatises which treat expressly of trigonometry, among which are those of *Emerson*, *Simpson*, *Bonnycastle*, *Cagnoli*, *Mauduit*, *Lacroix*, *Legendre*. In particular we refer to an excellent treatise on the subject by *Mr R. Woodhouse* of Caius college, Cambridge.

Description of the Table of Logarithmic Sines, &c.

That trigonometrical tables may be extensively useful, they ought to contain not only the sine, tangent, and secant to every minute of the quadrant, but also the logarithms of these numbers; and these are given in Dr Hutton's Mathematical Tables, a work which we have already mentioned; as, however, the sines, &c. or the *natural* sines, &c. as they are called, are much less frequently wanted than their logarithms, we have only given a table of the latter. See LOGARITHMS.

This table contains the logarithms of the sines and tangents, or the *logarithmic sines* and *tangents*, to every minute of the quadrant, the degrees at top and minutes descending down the left-hand side, as far as 45°, and from thence returning with the degrees at the bottom and the minutes ascending by the right-hand side to 90°, in such a manner that any arch on the one side is in the same line with its complement on the other, the respective sines, cosines, tangents, and cotangents, being in the same line with the minutes, and on the columns figured with their respective names at top when the degrees are at top, but at the bottom when the degrees are at the bottom. The differences of the sines and cosines are placed in columns to the right-hand, marked D; and the differences of the tangents and cotangents are placed in a column between them, each difference belonging equally to the columns on both sides of it. Also each differential number is set opposite the space between the numbers whose difference it is. All this will be evident by inspecting the table itself.

There are no logarithmic secants in the table, but these are easily had from the cosines; for since $\sec. a = \frac{\text{rad.}^2}{\cos. a}$, therefore, log. sec. $a = 2$ log. rad.—log. cos. a; now log. rad. $= 10$, therefore the log. secant of any arch is had by subtracting its log. cosine from 20.

The log. sine, log. tangent, or log. secant of any angle is expressed by the same numbers as the log. sine, log. tangent, or log. secant of its supplement; therefore, when an angle exceeds 90°, subtract it from 180° and take the log. sine, &c. of the remainder for that of the angle.

To find the log. sine of any angle expressed by degrees and minutes. If the angle be less than 45°, look for the number of degrees at the top, and opposite to the minutes on the left hand will be found the sine required; thus the log. sine of 8° 10′ is 9.15245. But if the angle be 45° or more than 45°, look for the degrees at the bottom and the minutes on the right hand, and opposite will be found the log. sine required. Thus the log. sine of 58° 12′ is 9.92936. The very same directions apply for the cosine, tangent, and cotangent; and from what has been said, the manner of finding the angle to degrees and minutes, having given its sine, &c. must be obvious.

If the angle consists of degrees, minutes, and seconds, find the sine or tangents to the degrees and minutes, and add to this a proportional part of the difference given in the column of differences for the seconds, observing that the whole difference corresponds to 1′ or 60″. Thus to find the log. sine of 30° 23′ 28″; first the sine of 30° 23′ is 9.70396. The difference is 21. As 60″ : 28″ :: 21 : $\frac{28 \times 21}{60} = 10$ nearly, the part of the difference to be added, therefore the sine of 30° 23′ 28″ is 9.70406.

On the contrary, let it be required to find the angle corresponding to the tangent 10.14152.

The next less tangent in the table is 10.14140, which corresponds to 54° 10′; the difference between the proposed tangent and next less is 12; and the difference between the next less and next greater, as given in the table, is 26; therefore, 26 : 12 :: 60″ : $\frac{12 \times 60}{26}$: 28″ nearly, hence the angle corresponding to the proposed log. tangent is 34° 10′ 28″.

SECTION II.

PLANE TRIGONOMETRY.

THE following propositions express as many of the properties of plane triangles as are essentially necessary in plane trigonometry.

THEOR. I.

In a right-angled plane triangle, as the hypothenuse is to either of the sides, so is the radius to the sine of the angle opposite to that side; and as either of the sides to the other side, so is the radius to the tangent of the angle opposite to that side.

Let ABC be a right-angled plane triangle (fig. 3.), of which AC is the hypothenuse. On A as a centre with any radius, describe the arch DE; draw EG at right angles to AB, and draw DF touching the circle at D, and meeting AC in F. Then EG is the sine of the angle A to the radius AD or AE, and DF is its tangent. Fig. 3.

The triangles AGE, ADF are manifestly similar to the triangle ABC. Therefore AC : CB :: AE : EG; that is, AC : CB :: rad. : sin. A.

Again

Again, AB : BC :: AD : DF; that is AB : BC :: rad. : tan. A.

Cor. In a right-angled triangle, as the hypothenuse to either of the sides, so is the secant of the acute angle adjacent to that side to the radius. For AF is the secant of the angle A to the radius AD; and AC : AB :: AF : AD, that is, AC : AB :: sec. A : rad.

Note. This proposition is most easily remembered when stated thus. *If in a right-angled triangle the hypothenuse be made the radius, the sides become the sines of the opposite angles; and if one of the sides be made the radius, the other side becomes the tangent of the opposite angle, and the hypothenuse its secant.*

Theor. II.

The sides of a plane triangle are to one another as the sines of the opposite angles.

Fig. 4. From B any angle of the triangle ABC (fig. 4.) draw BD perpendicular to AC. Then, by last theorem,

AB : BD :: rad. : sin. A,
also BD : BC :: sin. C : rad.

therefore *ex æquo* inversely (Geometry, Sect. III. Theor. 7.), AB : BC :: sin. C : sin. A.

Theor. III.

The sum of any two sides of a triangle is to their difference as the tangent of half the sum of the angle opposite to these sides to the tangent of half their difference.

Fig. 5. Let ABC, fig. 5. be a triangle; AB + BC : AB — BC :: tan. $\frac{1}{2}$ ($\angle$BCA + $\angle$BAC) : tan. $\frac{1}{2}$ ($\angle$BCA — $\angle$BAC).

In AB produced take BE = BC, and on B as a centre with BC or BE as a radius, describe the semicircle ECF meeting AC in D; join BD, CF, and CE, and from F draw FG parallel to AC, meeting CE in G.

Because the angles CFE, CBE, stand on the same arch CE, and the former is at the circumference of the circle, and the latter at the centre; therefore, the angle CFE is half the angle CBE (Geometry, Sect. II. Theor. XIV.); but the angle CBE is the sum of the angles BAC, BCA (Geometry, Sect. I. Theor. XXIII.); therefore the angle CFE is half the sum of the angles BCA, BAC.

Because the angle BDC is the sum of the angles BAC, ABD, therefore the angle ABD is the difference between the angles BDC, BAD; but since BD = BC, the angle BDC is equal to BCD or BCA, therefore ABD is the difference of the angles BCA, BAC; but ABD, or FBD, being an angle at the centre of the circle, is double the angle FCD at the circumference, which last is equal to the alternate angle CFG; therefore the angle CFG is half the difference of the angles BCA, BAC.

Because CE is manifestly the tangent of the angle CFE to the radius CF, and CG the tangent of the angle CFG to the same radius; therefore CE : CG :: tan. CFE : tan. CFG, that is, CE : CG :: tan. $\frac{1}{2}$ (BCA + BAC) : tan. $\frac{1}{2}$ (BCA — BAC); but because FG is parallel to AC, CE : CG :: AE : AF, that is, CE : CG :: AB + BC : AB — BC, therefore AB + BC : AB — BC : tan. $\frac{1}{2}$ (BCA + BAC) tan. $\frac{1}{2}$ (BCA — BAC).

Theor. IV.

If a perpendicular be drawn from any angle of a triangle to the opposite side or base; the sum of the segments of the base is to the sum of the other two sides of the difference of these sides to the difference of the segments of the base.

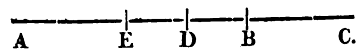
Let ABC be a triangle (fig. 6.), and BD a perpendicular drawn to the base from the opposite angle; AD + DC : AB + BC :: AB — BC : AD — DB. Fig. 6

On, B as a centre with the radius BC, describe a circle meeting AC in E, and AB in G, and the same line produced in F. Then AC : AF :: AG : AE; now AF = AB + BC, and AG = AB — BC, and because ED = DC, AE (or AD — DE) = AD — DC, therefore AC : AB + BC :: AB — BC : AD — DC.

Problem.

Having given the sum of any two quantities and also their difference, to find each of the quantities.

Solution. To half the sum add half the difference of the quantities, and it will give the greater; and from half the sum subtract half the difference, and it will give the less.



For let the greater of the two quantities be expressed by the line AB, and the less by BC; bisect AC in D, and take DE equal to DB, then AE = BC, and AB — BC = AB — AE = EB, and $\frac{1}{2}$ (AB — BC) = DB; also $\frac{1}{2}$ (AB + BC) = AD; now AB = AD + DB and BC = AD — DB, therefore the truth of the solution is evident.

In a plane triangle there are five distinct parts, which are so connected with one another, that any three of them being given, the remaining two may be found; these are, the three sides and any two of the three angles; as to the remaining angle, that depends entirely upon the other two, and may be found from them independent of the sides.

If one of the angles be a right angle, then the number of parts is reduced to four, and of these, any two being given, the remaining two may be found.

Solution of the Cases of Right-angled Plane Triangles.

In right-angled triangles there are four cases which may be resolved by the first theorem.

Case 1. The hypothenuse AC (fig. 7.) and an angle A being given, to find the sides AB, BC about the right angle. Fig. 7.

Solution. $\begin{cases} \text{Rad. : sin. A :: AC : BC,} \\ \text{Rad. : cos. A :: AC : AB.} \end{cases}$

Example. In the triangle ABC, let the hypothenuse AC be 144, and the angle A 39° 22′. Required the sides AB and BC.

To find AB.	Logarithms.	To find BC.	Log.
Rad. - -	10.00000	Rad. -	10.00000
Sin. A 39° 22′	9.80228	Cos. A 39° 22′	9.88824
AC 144 -	2.15836	AC 144	2.15836
BC = 91.3	1.96064	AB = 111.3	2.04660

Here

Here the logarithms of the second and third terms are added, and the logarithm of the first term subtracted or rejected from the sum.

CASE 2. A side AB, and an acute angle A (and consequently the other angle C) being given, to find the hypothenuse AC, and remaining side BC.

SOLUTION. $\begin{cases} \text{Cos. A : rad.} \quad :: \text{AB : AC,} \\ \text{Rad.} \quad \text{: tan. A :: AB : BC.} \end{cases}$

Example. In the triangle ABC are given AB 208, and the angle A 35° 16′, to find AC and BC.

To find AC.		To find BC.	
Cos. A 35° 16′	9.91194	Rad. - - -	10.00000
Rad. - - -	10.00000	Tan. A 35° 16′	9.84952
AB 208 -	2.31806	AB 208 -	2.31806
	12.31806	BC=147.1	2.16758
AC=254.7	2.40612		

CASE 3. The hypothenuse AC and a side AB being given, to find the angle A (and consequently C) and the side BC.

SOLUTION. $\begin{cases} \text{AC : AB} \quad \text{:: rad. : cos. A,} \\ \text{Rad. : sin. A :: AC : BC.} \end{cases}$

Example. Let the hypothenuse AC be 272, and the side AB 232. Required the angle A and the side BC.

To find A.		To find BC.	
AC 272 -	2.43457	Rad. - -	10.00000
AB 232 -	2.36549	Sin. A 31° 28′	9.71767
Rad. - -	10.00000	AC 272 - -	2.43457
	12.36549	BC 142 - -	2.15224
Cos. A=31° 28′	9.93092		

CASE 4. The sides AB and BC about the right angle being given, to find the angle A (and thence C) and the hypothenuse AC.

SOLUTION. $\begin{cases} \text{AB : BC : rad. : tan. A,} \\ \text{Cos. A : rad. : AB : AC.} \end{cases}$

Example. Let the side AB be 186, the side BC 152. Required the angle A, and the hypothenuse AC.

To find A.		To find AC.	
AB 186 -	2.26951	Cos. A 39° 15′	9.88896
BC 152 -	2.18184	Rad. - -	10.00000
Rad. - -	10.00000	AB 186 -	2.26951
	12.18184		12.26951
Tan. A=39° 15′	9.91233	AC=240.2	2.38055

Solution of the Cases of Oblique-angled Triangles.

In oblique-angled triangles there are also four cases, which, with their solutions, are as follows.

Fig. 8. CASE 1. Two angles A and B, and a side AB, being given, to find the other sides AC, BC.

SOLUTION. [illegible] B from 180°, and [illegible] AC and BC [illegible]

Sin. C [illegible]

Sin. C [illegible]

The truth of this [illegible]

Example. In the triangle [illegible] AB=266, the angle A [illegible] to find the sides AC and BC.

First, A+B=11[illegible], and [illegible] 4′=C.

Sin. C 69° 4′	9.97035	Sin. C [illegible]	[illegible]
Sin. B 72° 16′	9.97886	Sin. A [illegible]	[illegible]
AB 266 -	2.42488	AB 266 -	[illegible]
	12.40374		[illegible]
AC=271.3	2.43339	BC=177.9	[illegible]

CASE. 2. Two sides AC, CB (fig. 9.) and the angle A opposite to one of them, being given; to find the other angles B, C, and also the other side AB.

SOLUTION. The angle B is found by this proportion.

CB : AC :: sin. A : sin. B.

When CB is less than CA, the angle B admits of two values, one of which is the supplement of the other; because, corresponding to the same value of the side AC, and the angle A, the side BC may evidently have two distinct positions, viz. CB, C*b*. The angle CBA and its supplement C*b*A being found, the angle ACB, also the angle AC*b* may be found, by subtracting the sum of the two known angles from 180°, and then AB and A*b* may be found by these proportions.

Sin. A : Sin. ACB :: CB : AB,
Sin. A : Sin. AC*b* :: CB or C*b* : A*b*.

This is called the *ambiguous* case, on account of the angle B and the side AB having sometimes two values.

This solution, like the last, is deduced from Theorem II.

Example. Suppose AC 225, BC 180, and the angle A 42° 20′; to find the remaining parts.

CB 180 - -	2.25527
AC 225 - -	2.35218
Sin. A 42° 20′ -	9.82830
	12.18048
Sin. ABC=57° 20′ Or sin. A*b*C=122.40	9.92521

In the triangle ACB we have now the side AC and the angles CAB, CBA, therefore the remaining angle ACB and side AB may be found by Case 1.; and the same is true of the triangle AC*b*.

CASE

Plane Trigonometry.

CASE 3. Two sides CA, CB and the included angle C being given, to find the remaining angles B, A, and side AB.

SOLUTION. Find AC+CB, the sum of the sides, and AC—CB their difference; also find the sum of the angles A and B (that sum is the supplement of C), and half that sum; then half the difference of the angles will be got from this proportion. (See Theor. III.).

$AC+CB : AC-CB :: \tan.\frac{1}{2}(B+A) : \tan.\frac{1}{2}(B-A)$.

Having now the sum and difference of the angles B and A, the angles will be found by the rule given in the problem following Theor. IV.

The remaining side may be found by either of these proportions.

Sin. B : sin. C :: AC : AB; or sin. A : sin. C :: BC : AB.

Example. Let AC be 128, CB 90, and the angle C 48° 2′. Required the remaining parts of the triangle.

AC+CB 218	-	2.33846
AC—CB 38	-	1.57978
tan. $\frac{1}{2}$ (B+A) 65° 54′	-	10.34938
		11.92916
tan. $\frac{1}{2}$ (B—A) 21° 17′	-	9.59070

Hence by the given rule in the above-mentioned problem, B=87° 11′, A=43° 37′. As we now know all the angles and two sides, the remaining side may be found by Case 1.

Fig. 10. CASE 4. The three sides AB, BC and AC (fig. 10.) being given, to find the three angles A, B, C.

SOLUTION. Let fall a perpendicular CD upon the greatest of the three sides from the opposite angle. Then find the difference between AD and DB by this proportion.

$AB : AC+CB :: AC-CB : AD-DB$.

The segments AD, DB may now be found severally by the rule given for finding each of the quantities whose sum and difference is given, and then the angles A and B may be found by the following proportions.

CA : AD :: rad. : cos. A,
CB : BD :: rad. : cos. B.

The angles A, B being found, C of course is known. The first part of this solution follows from Theor. IV. the latter part from Theor. I.

Example. Let AB be 125, AC 105, and BC 95. Required the angles.

In this case AC+BC=200, AC—BC=10, therefore we have

$$125 : 200 :: 10 : AD-DB=\frac{200\times 10}{125}=16.$$

Now AD+DB=125, therefore AD=70.5 DB=54.5.

To find A.			To find B.		
AC 105	-	2.02119	BC 95	-	1.97772
AD 70.5	-	1.84819	BD 54.5	-	1.73640
Rad.	-	10.00000	Rad.	-	10.00000
		11.84819			11.73640
Cos. A 47° 49′		9.82700	Cos. B 55°	-	9.75868

Spherical Trigonometry.

For the application of plane trigonometry, see MENSURATION, Sect. I.

SECTION III.

SPHERICAL TRIGONOMETRY.

THEOR. I.

If a sphere be cut by a plane through the centre, the section is a circle.

THE truth of this proposition is evident from the definition of a sphere. See GEOMETRY, Sect. IX. Def. 3.

DEFINITIONS.

I. Any circle which is a section of a sphere by a plane passing through its centre, is called a *great circle* of the sphere.

COR. All great circles of a sphere are equal, and the centre of the sphere is their common centre, and any two of them bisect one another.

II. The *pole* of a great circle of the sphere is a point in the superficies of the sphere from which all straight lines drawn to the circumference of the circle are equal.

III. A *spherical angle* is that which on the superficies of a sphere is contained by two arches of great circles, and is the same with the inclination of the planes of these great circles.

IV. A *spherical triangle* is a figure upon the superficies of a sphere comprehended by three arches of three great circles, each of which is less than a semicircle.

THEOR. II.

The arch of a great circle between the pole and the circumference of another circle is a quadrant.

Let ABC be a great circle (fig. 11.), and D its pole; let the great circle ADC pass through D, and let AEC be the common section of the planes of the two circles, which will pass through E the centre of the circle, join DA, DC. Because the chord DA is equal to the chord DC, (Def. 2.) the arch DA is equal to the arch DC; now ADC is a semicircle, therefore the arches AD and DC are quadrants. Fig. 11.

COR. 1. If DE be drawn, the angle AED is a right angle, and DE being therefore at right angles to every line it meets with in the plane of the circle ABC, is at right angles to that plane. Therefore the straight line drawn from the pole of any great circle to the centre of the sphere is at right angles to the plane of that circle.

COR. 2. The circle has two poles D, D′, one on each

each side of its plane, which are the extremities of a diameter of the sphere perpendicular to the plane ABC.

Theor. III.

A spherical angle is measured by the arch of a great circle intercepted between the great circles containing the angle, and having the angular point for its pole.

Fig. 12. Let AB, AC be two arches of great circles containing the spherical angle BAC; let BC be an arch of a great circle intercepted between them, and having A for its pole, and let BD, CD, AD be drawn to D the centre of the sphere. The arches AB, AC are quadrants, (Theor. II.), and therefore the angles ADB, ADC right angles; therefore (Geometry, Sect. VII. Def. 4.) the angle BDC (which is measured by the arch BC) is the inclination of the planes of the circles BDA, CDA, and is equal to the spherical angle BAC (Def. 3.).

Cor. If AB, AC two arches of great circles meet in A, then A shall be the pole of a great circle passing through B and C.

Theor. IV.

Two great circles whose planes are perpendicular pass through each others poles.

Fig. 13. Let ACBD, AEBF be two great circles, the planes of which are at right angles to one another; from G the centre of a sphere, draw GC in the plane ABCD perpendicular to AB, then GC is also perpendicular to the plane AEBF, (Geometry, Sect. VII. Theor. 12.); therefore C is the pole of the circle AEBF, and if CG be produced to D, D is the other pole of the circle AEBF.

In the same manner, by drawing GE in the plane AEBF perpendicular to AB, and producing it to F, it is shewn that E and F are the poles of the circle ABCD.

Cor. 1. If two great circles pass through each others poles, their planes are perpendicular to one another.

Cor. 2. If of two great circles the first passes through the poles of the second, the second also passes through the poles of the first.

Theor. V.

If the angular points of any spherical triangle be made the poles of three great circles, another triangle will be formed by their intersections, such, that the sides of the one triangle will be respectively the supplements of the measures of the angles opposite to them in the other.

Fig. 14. Let the angular points of the triangle ABC be the poles of three great circles; which by their intersections form the three lunary surfaces DQ, FR, and EO; A being the pole of EF, B the pole of DF, and C the pole of ED. Then the triangle DEF, which is common to three lunary surfaces, will be in every respect supplemental to the triangle ABC.

For let each side of ABC be produced to meet the sides that contain the angle opposite to it, in the triangle DEF; then, because BC passes through the poles of ED, DF, ED, DF must also pass through the poles of BC. (Theor. II. Cor. 2.). Therefore the points D, Q are the poles of BC. In like manner R, F are the poles of AB, and E, O the poles of AC. Hence EL, FK are quadrants, (Theor. II.); and therefore EF is the supplement of KL, but since A is the pole of EF, KL is the measure of the angle at A; thus EF is the supplement of the measure of the angle at A. In like manner FD is the supplement of the measure of the angle at B, and DE the supplement of the measure of the angle at C.

Further, it will appear in the same manner that BC is the supplement of HM, the measure of the angle at D; that AB is the supplement of NK the measure of the angle at F; and that AC is the supplement of GL, the measure of the angle at E.

Theor. VI.

If from any point E, which is not the pole of the great circle ABC, there be drawn arches of great circles EA, EK, EB, &c. the greatest of these is EGA, which passes through G the pole of ABC, and EC the remainder of the semicircle is the least, and of the other, EK, EB, &c. EK which is nearer to EA is greater than EB, which is more remote.

Let AC be the common section of the planes of the great circles AEC, ABC; draw EH perpendicular to AC, which will be perpendicular to the plane of the circle ABC (Geometry, Sect. VII. Theor. XII.), and join AE, KE, BE, KH, BH. Then of all the straight lines drawn from H to the circumference, HA is the greatest, HC the least, and HK greater than HB: Therefore in the right-angled triangles EHA, EHK, EHB, EHC, which have the side EH common, EA is the greatest hypothenuse, EC the least, and EK greater than EB, consequently the arch EGA is the greatest, EC the least, and EK greater than EB. Fig. 15.

Theor. VII.

Any two sides of a spherical triangle are together greater than the third, and all the three sides are together less than a circle.

Let ABC be a spherical triangle, let D be the centre of the sphere, join DA, DB, DC. The solid angle at D is contained by three plane angles ADB, BDC, ADC, any two of which are greater than the third, (Geometry, Sect. VII. Theor. XV.); and therefore any two of the arches AB, BC, AC which measure these angles must be greater than the third arch. Fig 16.

To prove the second part of the proposition, produce the sides AB, AC until they meet again in E; then ECA and EBA are semicircles; now CB is less than CE+EB, therefore CB+CA+BA is less than CE+EB+CA+BA, but these four arches make up two semicircles; therefore CB+CA+BA is less than a circle.

Theor. VIII.

If two sides of a spherical triangle be equal, the angles opposite to them are equal, and conversely.

Fig. 17. In the triangle ABC, if the sides AB, AC be equal, the angles ABC, ACB are also equal. If AB, AC be quadrants, ABC, ACB are right angles. If not, let the tangent to the side AB at B meet EA the line of common section of the planes AB, AC in F, and let the tangents to the base BC at its extremities meet each other in G; also, let FC, FG, EC, and EB be joined. Then the triangles FEB, FEC have FE common, EB=EC, and the angle AEB=AEC, therefore FB =FC, and the angle FCE=FBE a right angle: hence FC is a tangent, and the triangles FGB, GCF are mutually equilateral, therefore the angle FBG=FCG, and consequently the spherical angle ABC=ACB.

Again, if the angles ABC, ACB be equal, the side AB=AC. For, if in fig. 14. the angle ABC be equal to ACB, the side DF of the supplemental triangle DEF will be equal to the side DE (Theor. V.); therefore the angle DEF=DFE, and consequently in the triangle ABC, the side AC=AB by Theorem V.

Cor. In any triangle the greater angle is subtended by the greater side; and conversely. For if the angle

Fig. 18. ACB be greater than ABC (fig. 18.) let BCD=ABC, then BD=DC, and AB=AD+DC, which is greater than AC (Theor. VII.). The converse is demonstrated in the same manner as the like property of plane triangles, (Geometry, Sect. I. Theor. XIII.).

Theor. IX.

All the angles of a spherical triangle are together greater than two, and less than six right angles.

Fig. 14. In the triangle ABC (fig. 14.) the three angles are altogether less than six right angles, because when added to the three exterior angles they only make six; and they are greater than two right angles, because their measures GH, KL, MN, added to DE, EF, FD, are equal to three semicircles; and DE, EF, FD being less than two semicircles (Theor. VII.) GH, KL, MN must be greater than one.

Theor. X.

Any two angles of a spherical triangle are together greater, equal, or less than two right angles, according as the sum of the opposite side is greater, equal, or less than a semicircle; and conversely.

Fig. 19. Let the sides AB, AC (fig. 19.) of the spherical triangle ABC be produced to meet in D; then it is evident, that according as the sum of AB, BC is greater, equal, or less than the semicircle ABD, the side BC will be greater, equal, or less than BD; the angle D or A will be greater, equal, or less than BCD, and the sum of the angle BAC, BCA greater, equal, or less than the sum of BCA, BCD, which is two right angles.

Cor. According as half the sum of any two sides of a spherical triangle is greater, equal, or less than a quadrant, half the sum of the opposite angles will be greater, equal, or less than a right angle.

Theor. XI.

In a right-angled triangle, according as either of the sides about the right angles is greater, equal, or less than a quadrant, its opposite angle is greater, equal, or less than a right angle; and conversely.

Let ABC (fig. 20.) be a triangle right-angled at B, Fig. 20. and let the sides AB, BC be produced to meet in D; then, because they pass through each others poles, E the middle point of BAD will be the pole of BCD; let a great circle pass through the points CE. The arch EC is a quadrant, and the angle ECB a right angle. Now it is plain, that according as AB is greater, equal, or less than the quadrant EB, the opposite angle ACB will be greater, equal, or less than the right angle ECB, and conversely.

Cor. 1. If the two sides be both greater, or both less than quadrants, the hypothenuse will be less than a quadrant; but if the one be greater and the other less, the hypothenuse will be greater than a quadrant, and conversely.

For in the triangles ABC, ADC, right-angled at B, D, in which the sides AB, BC are less, and consequently AD, DC greater than quadrants, the hypothenuse AC is less than a quadrant, because it is nearer to CB than the quadrant CE. But in the triangle *a* BC, of which the side *a* B is greater, and BC less than a quadrant, the hypothenuse *a* C is greater than a quadrant, because it is further from CB than CE is.

Cor. 2. In every spherical triangle, of which the two sides are not both quadrants, if the perpendicular from the vertex fall within, the angles at the base will be both acute, or both obtuse; but if it fall without, the one will be obtuse, and the other acute, and conversely.

Theor. XII.

In any right-angled spherical triangle, as radius is to the sine of the hypothenuse, so is the sine of one of the oblique angles to the sine of its opposite side.

Let ABC (fig. 21.) be a spherical triangle, having Fig. 21. a right angle at B; and let AD, BD, CD be drawn to the centre of the sphere. From C, in the plane DCA, let CE be drawn perpendicular to DA, and from E, in the plane DBA, draw EF perpendicular to the same line, and let CF be joined. Then because DA is perpendicular to the two lines CE, EF, it is perpendicular to the plane CEF, and consequently the plane CEF is perpendicular to the plane DBA; but the plane DCB is also perpendicular to DBA; therefore their line of common section CF is perpendicular to the same: Hence CFD, CFE are right angles. Now in the right-angled triangle CFE, rad. : CE :: sin. E : CF; but the angle CEF, being the inclination of the planes DCA, DBA, is the same with the spherical angle CAB, CE is the sine of AC, and CF the sine of BC; therefore rad. : sin. AC :: sin. A : sin. BC.

Cor.

Cor. 1. As radius to the cosine of either of the sides, so is the cosine of the other to the cosine of the hypothenuse.

Fig. 22. For let the great circle of which A is the pole, meet the three sides in D, E, F; then F is the pole of AD; and applying this proposition to the complemental triangle FCE, rad. : sin. FC :: sin. F : sin. CE; that is, rad. : cos. BC :: cos. AB : cos. AC.

Cor. 2. As radius to the cosine of one of the sides, so is the sine of its adjacent angle to the cosine of the other angle.

Theor. XIII.

In any right-angled triangle, as radius to the sine of one of the sides, so is the tangent of the adjacent angle to the tangent of the other side.

Fig. 23. From B let BE be drawn perpendicular to DA, and from E, EF also perpendicular to DA, in the plane DCA, to meet DC in F, and let BF be joined. It may be shown as in the preceding proposition, that FB is perpendicular to the plane DBA; hence FB is the tangent of BC, and FBE is a right-angled triangle; therefore rad. : EB :: tan. E : FB; that is rad. : sin. AB :: tan. A : tan. BC.

Cor. 1. As radius to the cosine of the hypothenuse, so is the tangent of one of the angles to the cotangent of the other. For, in the complemental triangle FCE, (fig. 22.) rad. : sin. CE :: tan. C : tan. FE, that is, rad. : cos. AC :: tan. C : cot. A, or, rad. : cos. AC :: tan. A : cot. C.

Cor. 2. As radius is to the cosine of one of the angles, so is the tangent of the hypothenuse to the tangent of the side adjacent to that angle.

For rad. : sin. FE :: tan. F : tan. CE; that is, rad. : cos. A :: cot. AB : cot. AC, or rad. : cos. A :: tan. AC : tan. AB.

Napier's Rule for Circular Parts.

Let the hypothenuse, the two angles, and the complements of the two sides of any right-angled spherical triangle be called the *five circular parts* of the triangle. Any one of these being considered as the *middle* part, let the two which are next to it be called the *adjacent* parts, and the remaining two the *opposite* parts. Then the two preceding theorems, with their corollaries, may be all expressed in one proposition adapted to practice, as follows.

In any right-angled spherical triangle, the rectangle under radius, and the cosine of the middle part, is equal to the rectangle under the cotangents of the adjacent parts, or to the rectangle under the sines of the opposite parts.

Fig. 24. Case 1. Let the hypothenuse AC be the middle part.

Then, rad. : cos. AC :: tan. C : cot. A (Theor. 13. Cor. 1.).

Therefore (rad. : tan. C ::) cot. C : rad. :: cos. AC : cot. A.

And rad. : cos. AB :: cos. BC : cos. AC (Theor. 12. Cor. 1.).

Case 2. Let the angle A be the middle part.

Then (Theor. 13. Cor. 2.) rad. : cos. A :: tan. AC : tan. AB.

Therefore, (rad. : tan. AC ::) cot. AC : rad. :: cos. A : tan. AB.

And (Theor. 12. Cor. 2.) rad. : cos. BC :: sin. C : cos. A.

Case 3. Let the complement of the side AB be the middle part.

Then (Theor. 13.) rad. : sin. AB :: tan. A : tan. BC.

Therefore (rad. : tan. A ::) cot. A : rad. :: sin. AB : tan. BC.

And (Theor. 12.) rad. : sin. AC :: sin. C : sin. AB.

We are indebted for the foregoing rule to Napier, the celebrated inventor of logarithms. It comprehends all the propositions which are necessary for the resolution of right-angled triangles, and being easily remembered, is perhaps one of the happiest instances of artificial memory that is known.

Theor. XIV.

In any spherical triangle, the sines of the sides are proportional to the sines of the opposite angle.

This proposition has been demonstrated in the case of right-angled triangles. Let ABC be any oblique-angled triangle, divided into two right-angled triangles, ABD, CBD, by the perpendicular BD, falling from the vertex upon the base AC. In the former, the complement of BD being the middle part, rad. $\times$ sin. BD $=$ sin. AB $\times$ sin. A, (Napier's Rule). In the latter, the complement of BD being the middle part, rad. $\times$ sin. BD $=$ sin. BC $\times$ sin. C. Hence sin. AB $\times$ sin. A $=$ sin. BC $\times$ sin. C, and sin. AB : sin. BC :: sin. C : sin. A. Fig. 25.

Cor. 1. The cosines of the two sides are to one another directly as the cosines of the segments of the base. This is proved by making AB, BC the middle part.

Cor. 2. The tangents of the two sides are to one another inversely as the cosines of the vertical angles. This will follow from making the angles ABD, CBD the middle parts.

Lemma 1. *The sum of the tangents of two arches is to their difference, as the rectangle under the sine and cosine of half their sum to the rectangle under the sine and cosine of half their difference.*

For, putting a and b for any two arches, by the arithmetic of sines (Algebra, § 353.),

$$\text{Sin. } a \cos. b + \cos. a \sin. b = \sin. (a+b).$$

Let each side of this equation be divided by cos. a cos. b, and we get

$$\frac{\sin. a}{\cos. a} + \frac{\sin. b}{\cos. b} = \frac{\sin (a+b)}{\sin. a \cos. b}$$

that is, $\tan. a + \tan. b = \dfrac{\sin. (a+b)}{\sin. a \cos. b}$.

In like manner, from the formula $\sin. (a-b) = \sin. a \cos. b - \cos. a \sin. b$, we get

$$\tan. a - \tan. b = \frac{\sin. (a-b)}{\sin. a \cos. b};$$

therefore tan. a + tan. b : tan. a — tan. b : sin. $(a+b)$: sin. $(a-b)$, and remarking that sin. $(a+b) = 2$ sin. $\frac{1}{2}(a+b)$,

$\frac{1}{2}(a+b)$ cos. $\frac{1}{2}(a+b)$, and sin. $(a-b) = 2$ sin. $\frac{1}{2}(a-b)$ cos. $\frac{1}{2}(a-b)$, (ALGEBRA, § 358.) it follows that tan. a + tan. b : tan. a — tan. b :: sin. $\frac{1}{2}(a+b)$ cos. $\frac{1}{2}(a+b)$: sin. $\frac{1}{2}(a-b)$ cos. $\frac{1}{2}(a-b)$.

2. LEMMA. *The sum of thesines of two arches is to their difference, as the rectangle under the sine of half the sum and cosine of half the difference of these arches is to the rectangle under the sine of half the difference and cosine of half the sum.*

For it has been shown in the arithmetic of sines (ALGEBRA, § 355), that

$$\text{Sin. }(p+q) + \text{sin. }(p-q) = 2 \text{ sin. } p \text{ cos. } q,$$
$$\text{Sin. }(p+q) - \text{sin. }(p-q) = 2 \text{ cos. } p \text{ sin. } q.$$

Let $p = \frac{1}{2}a + \frac{1}{2}b$, and $q = \frac{1}{2}a - \frac{1}{2}b$, so that $p+q = a$ and $p-q = b$, then these formulas become

$$\text{Sin. } a + \text{sin. } b = 2 \text{ sin. } \tfrac{1}{2}(a+b) \text{ cos. } \tfrac{1}{2}(a-b)$$
$$\text{Sin. } a - \text{sin. } b = 2 \text{ cos. } \tfrac{1}{2}(a+b) \text{ sin. } \tfrac{1}{2}(a-b).$$

Therefore, sin. a+sin. b : sin. a—sin. b :: sin. $\frac{1}{2}(a+b)$ cos. $\frac{1}{2}(a-b)$: cos. $\frac{1}{2}(a+b)$ sin. $\frac{1}{2}(a-b)$.

LEMMA 3. *The sum of the sines of two arches is to their difference, as the tangent of half the sum of these arches is to the tangent of half their difference.*

For, dividing the latter antecedent and consequent of the proportion in the foregoing lemma by cos. $\frac{1}{2}(a+b) \times$ cos. $\frac{1}{2}(a-b)$, we have sin. a+sin. b : sin. a—sin. b :: $\frac{\text{sin. }\frac{1}{2}(a+b)}{\text{cos. }\frac{1}{2}(a+b)} : \frac{\text{sin. }\frac{1}{2}(a-b)}{\text{cos. }\frac{1}{2}(a-b)}$, that is, because $\frac{\text{sin.}}{\text{cos.}} =$ tan. sin. a + sin. b : sin. a — sin. b :: tan. $\frac{1}{2}(a+b)$: tan. $\frac{1}{2}(a-b)$.

LEMMA 4. *The sum of the cosines of two arches is to their difference, as the cotangent of half the sum of these arches is to the tangent of half their difference.*

By Arithmetic of sines (ALGEBRA, § 355.),

$$\text{cos. }(p-q) + \text{cos. }(p+q) = 2 \text{ cos. } p \text{ cos. } q,$$
$$\text{cos. }(p-q) - \text{cos. }(p+q) = 2 \text{ sin. } p \text{ sin. } q.$$

Let $p = \frac{1}{2}(b+a)$ and $q = \frac{1}{2}(b-a)$, then $p-q = a$ and $p+q = b$, and the two formulas become

$$\text{cos. } a + \text{cos. } b = 2 \text{ cos. } \tfrac{1}{2}(b+a) \text{ cos. } \tfrac{1}{2}(b-a),$$
$$\text{cos. } a - \text{cos. } b = 2 \text{ sin. } \tfrac{1}{2}(b+a) \text{ sin. } \tfrac{1}{2}(b-a);$$

Hence, cos. a+cos. b : cos. a—cos. b :: cos. $\frac{1}{2}(b+a)$ cos. $\frac{1}{2}(b-a)$: sin. $\frac{1}{2}(b+a)$ sin. $\frac{1}{2}(b-a)$;

and dividing the latter antecedent and consequent by sin. $\frac{1}{2}(b+a)$ cos. $\frac{1}{2}(b-a)$,

$$\text{cos. } a + \text{cos. } b : \text{cos. } a - \text{cos. } b :: \frac{\text{cos. }\frac{1}{2}(b+a)}{\text{sin. }\frac{1}{2}(b+a)} : \frac{\text{sin. }\frac{1}{2}(b-a)}{\text{cos. }\frac{1}{2}(b-a)},$$ that is, because $\frac{\text{cos.}}{\text{sin.}} =$ cot. and $\frac{\text{sin.}}{\text{cos.}} =$ tan. we have cos. a + cos. b : cos. a — cos. b :: cot. $\frac{1}{2}(b+a)$: tan. $\frac{1}{2}(b-a)$.

Fig. 26. IN the demonstration of the remaining theorems, we shall put A, B for the angles A and B at the base of the spherical triangle ACB (fig. 26.) a and b for the sides opposite to these angles, p and q for the segments of the base BD, AD made by the perpendicular arch CD, P and Q for the vertical angles BCD, ACD; we shall also put s for $\frac{1}{2}(a+b)$, d' for $\frac{1}{2}(a-b)$, s' for $\frac{1}{2}(p+q)$, d' for $\frac{1}{2}(p-q)$, S for $\frac{1}{2}$(A+B), D for $\frac{1}{2}$(A—B), S′ for $\frac{1}{2}$(P+Q), and D′ for $\frac{1}{2}$(P—Q).

THEOR. XV.

In any spherical triangle, the tangent of half the sum of the segments of the base is to the tangent of half the sum of the two sides, as the tangent of half their difference to the tangent of half the difference of the segments of the base.

For by Theor. XIV. Cor. 1. cos. a : cos. b :: cos. p : cos. q; therefore, cos. a + cos. b : cos. a — cos. b :: cos. p + cos. q : cos. p — cos. q, hence (Lemma 4.) cot. s : tan. d' :: cot. s' : tan. d', or cot. s : cot. s' :: tan. d : tan d'; but cot. s : cot. s' :: tan. s' : tan. s, therefore, tan s' : tan. s :: tan. d : tan. d'. This proposition expressed in words at length is the theorem to be demonstrated.

THEOR. XVI.

The cotangent of half the sum of the vertical angles and the tangent of half their difference, or the cotangent of half their difference and the tangent of half their sum, according as the perpendiculars fall within or without, are reciprocally proportional to the tangents of half the sum and half the difference of the angles at the base.

For, taking the case in which the perpendicular CD (fig. 27.) falls within, let EFG be the supplemental triangle, let the arches GE, GF meet again in L, and produce CA, CB to meet EF in H and K. Because G and L are the poles of AB, the perpendicular CD, if produced, will pass through G and L; let it meet EF in I; then, because C is the pole of EF, the arch GCI is perpendicular to EF, and since E is the pole of BC, KE=a quadrant=FH, and EH=KF, and IF—IE=IK—IH. In the triangle LEF, by the preceding proposition, tan. $\frac{1}{2}$(FI+IE) : tan. $\frac{1}{2}$(FL+LE) :: tan. $\frac{1}{2}$(FL—LE) : tan. $\frac{1}{2}$(FI—IE) or tan. $\frac{1}{2}$(KI—IH). Now FI+IE, or FE, being the supplement of C, (Theor. 5.), tan. $\frac{1}{2}$ FE=cot. $\frac{1}{2}$C; and FL, LE being the supplements of FG and GE, FL and LE are the measures of the angles A, B; moreover, IK, IH are the measures of the angles BCD, ACD, therefore, cot. $\frac{1}{2}$ C, or cot. $\frac{1}{2}$(P+Q) : tan. $\frac{1}{2}$(A+B) : tan. $\frac{1}{2}$(A—B) : tan. $\frac{1}{2}$(P—Q). In the very same way it may be proved, when the perpendicular falls without the triangle, that cot. $\frac{1}{2}$(P—Q) : tan. $\frac{1}{2}$(A+B) :: tan. $\frac{1}{2}$(A—B) : tan. $\frac{1}{2}$(P+Q). Fig. 27.

THEOR. XVII.

In any spherical triangle, the sine of half the sum of the sides is to the sine of half their difference, as the cotangent of half the vertical angle to the tangent of half the difference of the angles at the base.

For since tan. a : tan. b :: cos. Q : cos. P, therefore, tan.

tan. a+tan. b : tan. a—tan. b :: cos. Q+cos. P : cos. Q—cos. P; hence, by Lemma 2. and 4.

sin. s. cos. s : sin. d cos. d :: cot. S′ : tan. D′ . . . (1).

Again, because (by Theor. XIV.) sin. a : sin. b :: sin. A : sin. B, therefore, sin. a+sin. b : sin. a—sin. b :: sin. A+sin. B : sin. A—sin. B; hence, (by Lemma 2. and 3.)

sin. s cos. d : sin. d cos. s :: tan. S : tan. D . . . (2).

Taking now the product of the corresponding terms of the proportions (1) and (2), and rejecting the factor cos. s cos. d, which is common to the first antecedent and consequent of the resulting proportion, we have,

sin.^{2} s : sin.^{2} d :: cot. S′ tan. S : tan. D′ tan. D.

But since by Theor. XVI. tan. S : tan. D′ :: cot. S′ : tan. D, therefore cot. S′ tan. S : tan. D′ tan. D :: cot.^{2} S′ : tan.^{2} D; therefore, sin.^{2} s : sin.^{2} d :: cot.^{2} S′ : tan.^{2} D, and sin. s : sin. d :: cot. S′ : tan. D, this proportion when expressed in words is the proportion to be demonstrated.

Theor. XVIII.

In any spherical triangle, the cosine of half the sum of the two sides is to the cosine of half their difference, as the cotagent of half the vertical angle to the tangent of half the sum of the angles at the base.

For it has been proved in last theorem that

sin. s cos. s : sin. d cos. d :: cot. S′ : tan. D′
sin. s cos. d : sin. d cos. s :: tan. S : tan. D;

therefore, dividing the terms of the first of these two proportions by the corresponding terms of the second, we get

$$\frac{\text{cos. } s}{\text{cos. } d} : \frac{\text{cos. } d}{\text{cos. } s} :: \frac{\text{cot. S}'}{\text{tan. S}} : \frac{\text{tan. D}'}{\text{tan. D}}.$$

Hence, multiplying the first and second terms by cos. s × cos. d, and the third and fourth by tan. S tan. D, we have

cos.^{2} s : cos.^{2} d :: cot. S′ tan. D : tan. S tan. D′.

But since by Theor. XVI. tan. D : tan. D′ :: cot. S′ : tan. S, therefore, cot. S′ tan. D : tan. S tan. D′ :: cot.^{2} S′ : tan.^{2} S; therefore, cos.^{2} s : cos.^{2} d :: cot.^{2} S′ : tan.^{2} S, and cos. s : cos. d :: cot. S′ : tan. S.

Theor. XIX.

In any spherical triangle, the sine of half the sum of the angles at the base is to the sine of half their difference, as the tangent of half the base to the tangent of half the difference of the two sides.

For the same construction being made as in Theor. XVI. in the triangle ELF (fig. 27.) sin. $\frac{1}{2}$ (FL+LE) : sin. $\frac{1}{2}$ (FL—LE) :: cot. $\frac{1}{2}$ L : tan. $\frac{1}{2}$ (E—F) (Theor. XVII.); but EFG being the supplemental triangle of ABC, LF and LE are the measures of A and B, L is the supplement of AB, and LFE, LEF are the measures of the sides AC, BC (Theor. V.); therefore sin. $\frac{1}{2}$ (A+B) : sin. $\frac{1}{2}$ (A—B) :: tan. $\frac{1}{2}$ AB : tan. $\frac{1}{2}$ (BC—AC). Fig. 27.

Theor. XX.

In any spherical triangle, the cosine of half the sum of the angles at the base is to the cosine of half their differences as the tangent of half the base to the tangent of half the sum of the two sides.

For in the triangle ELF, cos. $\frac{1}{2}$ (LF+LE) : cos. $\frac{1}{2}$ (LF—LE) :: cot. $\frac{1}{2}$ L : tan. $\frac{1}{2}$ (E+F) (Th. XVIII.) that is, because of the relation of the triangle FLE to ABC, as expressed in last theorem, cos. $\frac{1}{2}$ (A+B) : cos. $\frac{1}{2}$ (A—B) :: tan. $\frac{1}{2}$ AB : tan. $\frac{1}{2}$ (BC+AC). Fig. 27.

Scholium.

Let one of the six parts of any spherical triangle be neglected; let the one opposite to it, or its supplement, if an angle, be called the *middle part*, the two next to it the *adjacent parts*, and the remaining two the *opposite parts*. Then the four preceding propositions, which are called *Napier's Analogies*, because first invented by him, may be included in one, as follows.

In any spherical triangle, the sine or cosine of half the sum of the adjacent parts, is to the sine or cosine of half their difference, as the tangent of half the middle part to the tangent of half the difference or half the sum of the opposite parts, that is,

Sin. $\frac{1}{2}$ (A+a) : sin. $\frac{1}{2}$ (A—a) :: tan. $\frac{1}{2}$ M : tan. $\frac{1}{2}$ (O—o).

Cos. $\frac{1}{2}$ (A+a) : cos. $\frac{1}{2}$ (A—a) :: tan. $\frac{1}{2}$ M : tan. $\frac{1}{2}$ (O+o).

When A, a and M are given, by the first proportion, $\frac{1}{2}$ (O—o) is found, and by the second $\frac{1}{2}$ (O+o); thence O and o may be had immediately by the problem following Theor. IV. Plane Trigonometry.

The Cases of Right-angled Spherical Triangles.

In a right-angled triangle, let c denote the side opposite the right angle, a, b the sides containing it, and A, B the opposite angles, A being opposite to a, and B to b. Then, combining these quantities two by two, there will be found to be six distinct combinations, or cases. Fig. 28.

Case 1. When c, A, the hypothenuse and one of the angles are given; to find a, b, B.

a is found by Theor. XII.; b by Theor. XIII. Cor. 2. and B by Theor. XIII. Cor. 1.

Case 2. Given a, B, a side and its adjacent angle. Sought, A, b, c.

A is found by Theor. XII. Cor. 2.; b by Theor. XIII.; c by Theor. XIII. Cor. 2.

Case 3. Given a, A, a side and its opposite angle; to find b B, c.

b is found by Theor. XIII.; B by Theor. XII. Cor. 2.; c by Theor. XII.

Case 4. Given c, a, the hypothenuse, and one of the sides; to find A, b, B.

A is found by Theor. XII.; b by Theor. XII. Cor. 1.; B by Theor. XIII. Cor. 2.

Spherical Trigonometry.

Case 5. Given a, b, the two sides. Sought A, B, c.
A is found by Theor. XIII.; B by the same; c by Theor. XII. Cor. 1.

CASE 6. Given A, B, the two angles. Sought a, b, c.
a and b are found by Theor. XII. Cor. 2.; c by Theor. XIII. Cor. 1.

THE case may be all resolved also by *Napier's Rule*, observing to make each of the things given the middle part; then two of the required parts will be found, and the remaining part is found by making it the middle part.

By Theor. II. and Cor. 1. each of the unknown parts is, in every case except the third, limited to one value.

The cases of Oblique-angled Spherical Triangles.

In any spherical triangle let the sides be denoted by a, b, c, and the opposite angles by A, B, C respectively.

Let p, q denote the segments into which a side is divided by a perpendicular from the opposite angle, and P, Q the parts into which it divides the angle. Combining the six quantities a, b, c, A, B, C, three by three, there are found six distinct combinations or cases.

CASE 1. Given a, A, b, two sides and an angle opposite to one of them. Sought c, B, C.
B is found by Theor. XIV.; c by either Theor. XIX. or Theor. XX.; C by Theor. XVII. or Theor. XVIII.

CASE 2. Given A, a, B, two angles and a side opposite to one of them. Sought b, c, C.
b is found by Theor. XIV.; c and C as in Case 1.

CASE 3. Given a, C, b, two sides and the included angle. Sought A, B, c.

Find $\frac{1}{2}$ (A—B) by Theor. XVII. and $\frac{1}{2}$ (A+B) by Theor. XVIII. and thence A and B by the rule SECT. II. for finding each of two quantities whose sum and difference are given. All the angles being known, also two sides, c is found by Theor. XIV.

CASE 4. Given A, c, B, two angles and a side between them. Sought a, C, b.

Find $\frac{1}{2}$ $(a—b)$ by Theor. XIX. and $\frac{1}{2}$ $(a+b)$ by Theor. XX. and thence a, b. All the sides and two angles being now known, C is found by Theor. XIV.

CASE 5. Given a, b, c, the three sides. Sought A, B, C.

Draw a perpendicular from any one of the angles, dividing the opposite side into the segments p, q. Find $\frac{1}{2}$ $(p—q)$ by Theor. XV. and then, from $\frac{1}{2}$ $(p+q)$ and $\frac{1}{2}$ $(p—q)$, find p, q. The triangle being now resolved into two right-angled triangles, the angles may be found by Case 4. of right-angled triangles.

CASE 6. Given A, B, C, the three angles. Sought a, b, c.

Draw a perpendicular, dividing any one of the angles into the parts P, Q. Find $\frac{1}{2}$ (P—Q) by Theor. XVI. and then P, Q. The triangle being now resolved into two right-angled triangles, the sides may be found by Case 6. of right-angled triangles.

By Theor. X. XI. and Cor. each of the unknown parts is limited to one value in all the cases, except in some of the subcases of the first and second.

As every oblique-angled triangle may be resolved into two right-angles, all these cases may be resolved by means of *Napier's Rule*, and the 15th proposition only. And the cases may be reduced to three, by using the supplemental triangle.

T R I

Trihilatæ ‖ Tringa.

TRIHILATÆ, from *tres*, "three," and *hilum*, "an external mark on the seed;" the name of the 23d class in Linnæus's Fragments of a Natural Method; consisting of plants with three seeds, which are marked with an external cicatrix or scar, where they are fastened within the fruit. See BOTANY.

TRIM, implies in general the state or disposition by which a ship is best calculated for the several purposes of navigation.

Thus the trim of the hold denotes the most convenient and proper arrangement of the various materials contained therein relatively to the ship's motion or stability at sea. The trim of the masts and sails is also their most apposite situation with regard to the construction of the ship and the effort of the wind upon her sails. See SEAMANSHIP.

TRINGA, SANDPIPER; a genus of birds belonging to the order of grallæ. See ORNITHOLOGY *Index*.

Tringa ‖ Trinitarians.

TRINIDAD, an island in the gulf of Mexico, separated from New Andalusia, in Terra Firma, by a strait about three miles over. The soil is fruitful, producing sugar, cotton, Indian corn, fine tobacco, and fruits. It was taken by Sir Walter Raleigh in 1595, and by the French in 1676, who plundered the island and then left it. It is about 62 miles in length, and 45 in breadth; and was discovered by Christopher Columbus in 1498. It is now in the possession of Britain. What was called a bituminous lake in this island, appears, from the experiments of Mr Hatchet, to be a porous stone from which the mineral pitch exudes.

TRINITARIANS, those who believe in the Trinity; those who do not believe therein being called *Antitrinitarians*.

2

TRINITY,

Fig. 1.

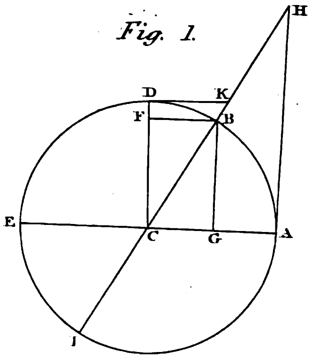


Fig. 2.

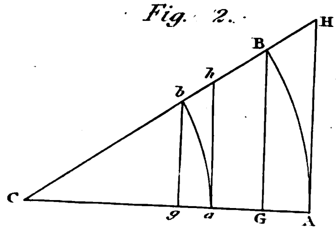


Fig. 3.

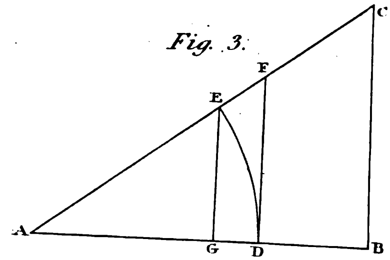


Fig. 5.

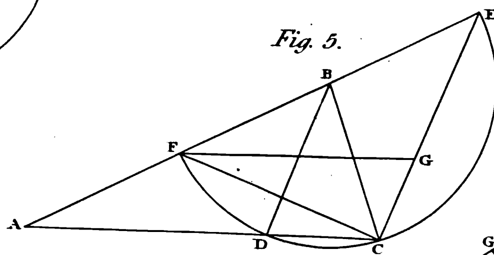


Fig. 6.

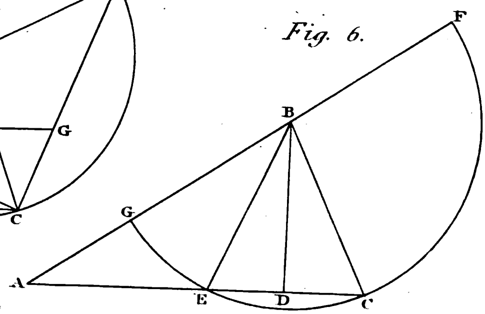


Fig. 4.

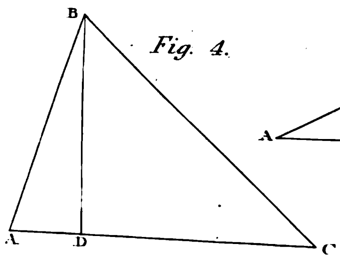
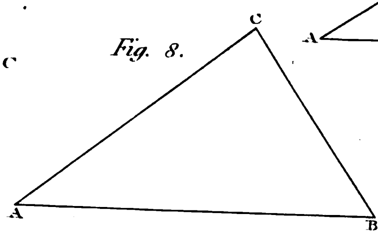


Fig. 8.



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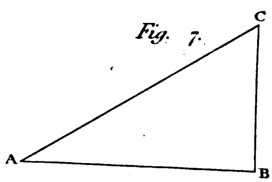


Fig. 9.

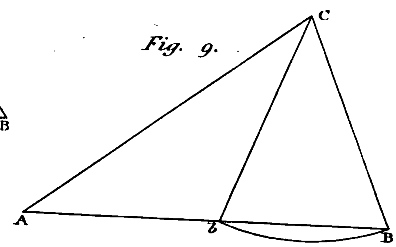


Fig. 12.

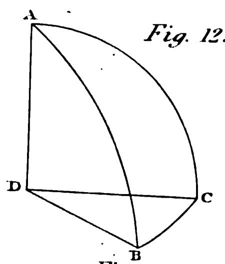


Fig. 10.

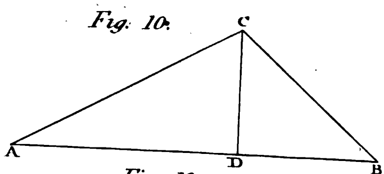
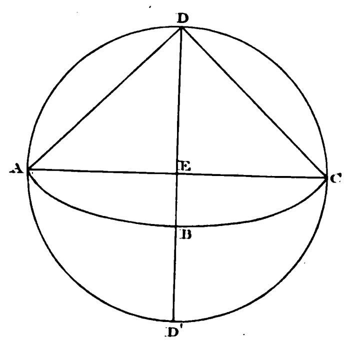


Fig. 11.



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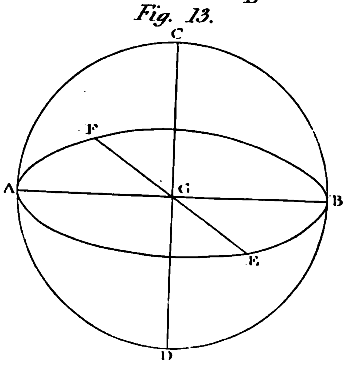

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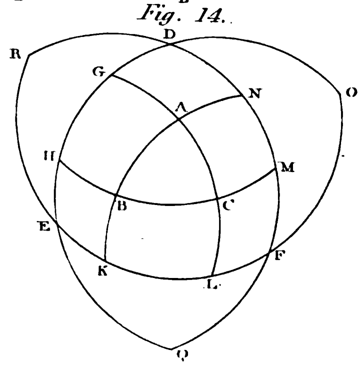


W. Train Sculpt.

Fig. 15.

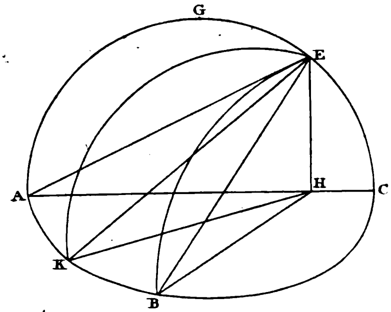


Fig. 16.

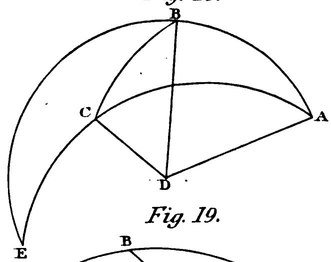
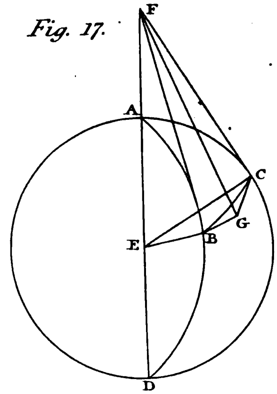


Fig. 17.



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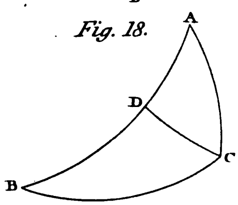
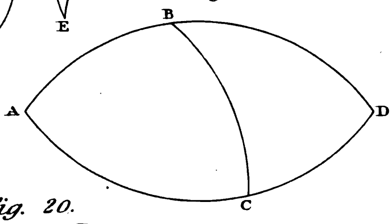


Fig. 19.



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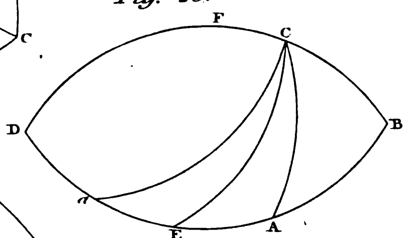
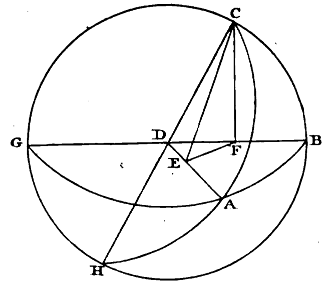


Fig. 21.



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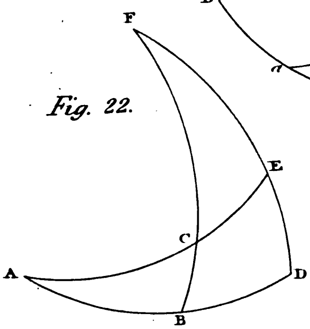

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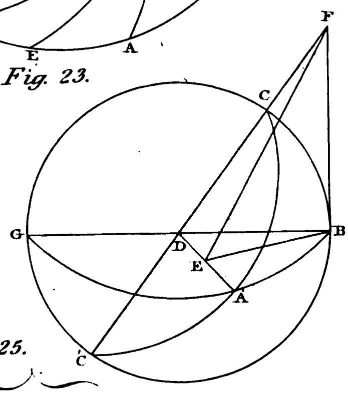

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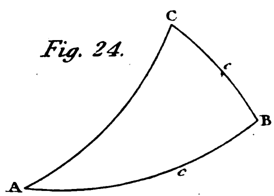

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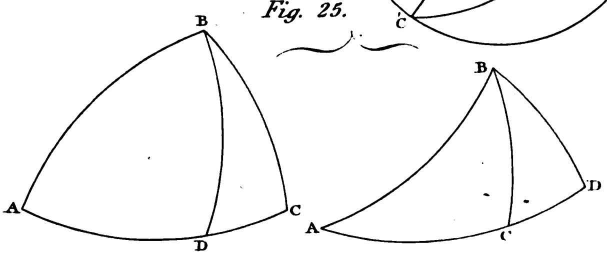


Fig. 26.

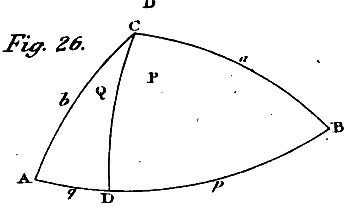


Fig. 27.

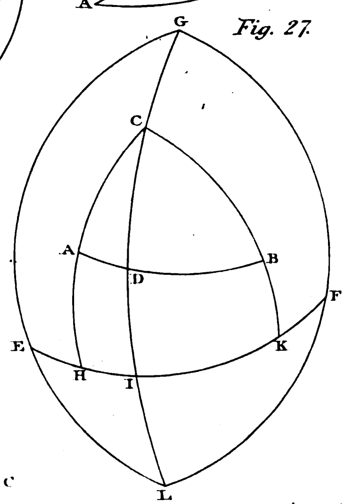
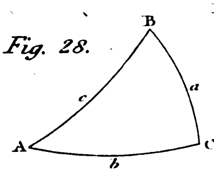


Fig. 28.



W. Tryon Sculp.

TRINITY, in *Theology*, the ineffable mystery of three persons in one God; Father, Son, and Holy Spirit. See THEOLOGY.

TRINITY-House. See LONDON, N° 49.

TRINITY-Sunday, a festival observed on the Sunday next after Whitsunday, in honour of the holy Trinity. The observation of this festival was first enjoined in the council of Arles, anno 1260.

TRINOBANTES, in *Ancient Geography*, a people of Britain, supposed to have occupied Middlesex and Essex.

TRIO, in *Music*, a part of a concert wherein three persons sing; or, more properly, a musical composition consisting of three parts.

TRIPHTHONG, in *Grammar*, an assemblage or concourse of three vowels in one syllable; as *quæ*.

TRIPLE, in *Music*, is one of the species of measure or time. See MUSIC.

TRIPOD, in antiquity, a famed sacred seat or stool, supported by three feet, whereon the priest and sibyls were placed to render oracles. It was on the tripod that the gods were said to inspire the Pythias with that divine fury and enthusiasm wherewith they were seized at the delivery of their predictions.

TRIPOLI, a country of Africa, in Barbary; bounded on the north by the Mediterranean sea; on the south, by the country of the Beriberies: on the west, by the kingdom of Tunis and Biledulgerid; and on the east, by Egypt. It is about 925 miles along the sea coast; but the breadth is various. Some parts of it are pretty fruitful; but that towards Egypt is a sandy desert. It had the title of a *kingdom*; but is governed by a dey. Early in the last century Tripoli shook off its dependence on the grand Turk. In other respects the government is not essentially changed. It is still a military despotism of the most ferocious description. Its piracies are now confined to Naples, Sardinia, and other states which have no efficient navy. See BARBARY STATES, SUPPLEMENT.

TRIPOLI, a considerable town of Africa, and capital of a state of the same name in Barbary, with a castle and a fort. It is pretty large, and the inhabitants are noted pirates. It was taken by Charles V. who settled the knights of Malta there; but they were driven away by the Turks in 1551. It was formerly very flourishing; and has now some trade in stuffs, saffron, corn, oil, wool, dates, ostrich feathers, and skins: but they make more of the Christian slaves which they take at sea; for they either set high ransoms upon them, or make them perform all sorts of work. It is seated on the coast of the Mediterranean, in a sandy soil, and surrounded by a wall, strengthened by other fortifications. E. Long. 13. 12. N. Lat. 32. 34.

TRIPOLI, called *Tripolis* of *Syria*, to distinguish it from Tripoli in *Barbary*, received its name from its being anciently formed of three cities at a small distance from each other, one of which belonged to the Aradians, or ancient kingdom of Arad, the second to the Sidonians, and the third to the Tyrians, perhaps as a common mart to those maritime powers. The present town of Tripoli is built at the distance of a mile and a half from the other, upon the declivity of a hill facing the sea, in 34° 20′ north latitude, and in 35° 50′ east longitude from Greenwich. It is surrounded with walls, fortified with seven high strong towers, and a castle, all of Gothic architecture; but the streets are narrow, and the houses low. The city contains about 8000 houses, and near 60,000 inhabitants, consisting of Turks, Christians, and Jews. The basha, or pasha, who resides in the castle, where there is a garrison of 200 janizaries, governs the adjacent territory, in which there is plenty of fruit, and a great number of mulberry trees, which enable the inhabitants to carry on a silk manufacture, from which they draw considerable profit.

All the environs of Tripoli are laid out in orchards, where the nopal grows spontaneously, and the white mulberry is cultivated for the silk-worm; the pomegranate, orange, and lemon trees for their fruit, which is here very fine. The country, though delightful to the eye, is unhealthy; from July to September, epidemic fevers, like those of Scanderoon and Cyprus, prevail, and are principally caused by the artificial inundations made for the purpose of watering the mulberry trees, to enable them to throw out their second leaves, and from a want of free circulation of air, the city being open only to the westward.

TRIPOLI, a species of argillaceous earth, much used in the polishing of metals. See MINERALOGY *Index*.

TRIPTOLEMUS, LAWS OF. See MYSTERIES, N° 74.

TRIQUETROUS, among botanists, denotes a fruit or leaf that has three flat sides or faces.

TRIREMIS, in antiquity, a galley with three ranks of oars on a side.

TRISMEGISTUS, an epithet or surname given to one of the two Hermeses. See THOTH.

TRISMUS, the LOCKED JAW. See MEDICINE, N° 280.

TRISYLLABLE, in *Grammar*, a word consisting of three syllables.

TRITICUM, WHEAT; a genus of plants belonging to the class of triandria; and in the natural system ranging under the 4th order, *Gramina*. See BOTANY and AGRICULTURE *Index*.

TRITON, a sea demigod, held by the ancients to be an officer or trumpeter of Neptune, attending on him, and carrying his orders from sea to sea.

TRITURATION, the act of reducing a solid body into a subtile powder; called also *pulverisation* and *levigation*.

TRIUMPH, in Roman antiquity, a public and solemn honour conferred by the Romans on a victorious general, by allowing him a magnificent entry into the city.

The greater triumph, called also *curulis*, or simply the *triumph*, was decreed by the senate to a general, upon the conquering of a province or gaining a signal victory. The day appointed for the ceremony being arrived, scaffolds were erected in the forum and circus, and all the other parts of the city where they could best behold the pomp: the senate went to meet the conqueror without the gate called *Capena* or *Triumphalis*, and marched back in order to the Capitol; the ways being cleared and cleansed by a number of officers and tipstaffs, who drove away such as thronged the passage or straggled up and down. The general was clad in a rich purple robe, interwoven with figures of gold, setting forth his great exploits; his buskins were beset with pearl; and he wore a crown, which at first was only laurel, but afterwards gold; in one hand he bore a a branch of laurel, and in the other a truncheon. He was carried in a magnificent chariot, adorned with ivory and plates of gold, drawn usually by two white horses; though sometimes by other animals, as that of Pompey, when he triumphed over Africa, by elephants; that of Mark Antony by lions; that of Heliogabalus by tygers; that of Aurelian by deer, &c. His children were at his feet, and sometimes on the chariot-horses. The procession was led by the musicians, who played triumphal pieces in praise of the general: these were followed by young men, who led the victims to the sacrifice, with their horns gilded, and their heads adorned with ribbauds and garlands; next came the carts and waggons, loaded with all the spoils taken from the enemy, with their horses, chariots, &c.; these were followed by the kings, princes, and generals, who had been taken captives, loaded with chains; after these appeared the triumphal chariot, before which, as it passed, they all along strewed flowers, and the people with loud acclamations called out *Io triumphe!* The chariot was followed by the senate, clad in white robes; and the senate by such citizens as had been set at liberty or ransomed; and the procession was closed by the priests and their officers and utensils, with a white ox led along for the chief victim. In this order they proceeded through the triumphal gate, along the Via Sacra, to the Capitol, where the victims were slain. In the mean time all the temples were open, and all the altars loaded with offerings and incense; games and combats were celebrated in the public places, and rejoicings appeared everywhere.

TRIUMVIR, one of three persons who govern absolutely, and with equal authority, in a state. It is chiefly applied to the Roman government: Cæsar, Pompey, and Crassus, were the first triumvirs who divided the government among them. There were also other officers so called; as the triumviri or tresviri capitales, who were the keepers of the public gaol: they had the office of punishing malefactors; for which purpose they kept eight lictors under them.

TROAS, a country of Phrygia in Asia Minor, of which Troy was the capital. When Troas is taken for the whole kingdom of Priam, it may be said to contain Mysia and Phrygia Minor: but if only applied to that part of the country where Troy was situated, its extent is confined within very narrow limits. Troas was anciently called Dardania. See TROJA.

TROCHÆUS, in prosody, a foot consisting of a long and short syllable.

TROCHANTER, in *Anatomy*. See there, N° 58.

TROCHE, in *Pharmacy*, a sort of medicine made of glutinous substances into little cakes, and afterwards exsiccated. See MATERIA MEDICA *Index*.

TROCHILUS, HUMMING BIRD, a genus of birds belonging to the order of picæ. See ORNITHOLOGY *Index*.

TROGLODYTES, in the *Ancient Geography*, a people of Ethiopia, said to have lived in caves under ground. Pomponius Melo gives a strange account of the Troglodytes: he says they did not so properly speak as shriek; and that they lived on serpents.

TROGUS POMPEIUS, a Latin universal historian to the time of Augustus Cæsar, of whom we have only an abridgement by Justin, flourished about 41 B. C.

TROJA, the capital city of Troas, or, according to others, a country of which Ilium was the capital. It was built on a small eminence near Mount Ida, and the promontory of Sigæum, at the distance of about four miles from the sea-shore. Dardanus the first king of the country built it, and called it *Dardania*, and from Tros one of his successors it was called *Troja*, and from Ilus *Ilion*. This city has been celebrated by Homer and Virgil.

A description of the plain of Troy has been published in French in the 3d volume of the Philosophical Transactions of The Royal Society of Edinburgh, by M. Chevalier. The city of Troy, according to him, stood on the present site of the modern village of Bounarbachi, which is situated four leagues from the sea, on the side of an eminence, at the termination of a spacious plain, the soil of which is rich and of a blackish colour. Close to the village is to be seen a marsh covered with tall reeds; and the situation is impregnable on all sides except at Erin (Homer's ερινεος), the *hill of wild fig-trees*, which extended between the Scæan gate and the sources of the Scamander. In the plain there are several conical mounds or barrows, some of them 100 feet in diameter at the base; and which the author maintains to be the identical tombs raised over the ashes of the heroes of the Trojan war.

Since Chevalier's dissertation appeared, this plain has been investigated by Mr Morritt, Mr Gell, Dr Clarke, Mr Hobhouse, and several other travellers. Dr Clarke traversed the ground in different directions seventeen times. He rejects the hypothesis of Chevalier, and reasoning from the authority of Strabo, and from the scite of New Ilium, which he ascertained by inscriptions found among ruins, he fixes the situation of Troy four or five miles to the northward of Bournabachi, near a sluggish rivulet, called Califat Osmack, which he considers to be the Simois. The name of the Scamander is still preserved in the Mender, the most considerable stream in the district, rising in Mount Ida, as described by Homer; and the Thymbrius is still preserved in the Thymbrek. Dr Clarke also finds objects corresponding to the Calicolone, the tomb of Ilus, and the Throsmos or mound of the plain. But very strong objections have been stated to Dr Clarke's opinions by Mr Hobhouse and others; and, upon the whole, the more the subject is investigated, the more insuperable difficulties seem to present themselves to any attempt to identify the places and objects alluded to by the poet. See Clarke's Travels, vol. 3d, 8vo. and Edinburgh Review, vol. 6th, p. 257.

TROLLIUS, GLOBE-FLOWER, or *Lucken Gowan*, a genus of plants belonging to the class of polyandria; and in the natural system ranging under the 26th order, *Multisiliquæ*. See BOTANY *Index*.

TROMP, MARTIN HAPPERTZ VAN, a celebrated Dutch admiral, was born at the Baille, in Holland. He raised himself by his merit, after having distinguished himself on many occasions, especially at the famous engagement near Gibraltar in 1607. He passed for one of the greatest seamen that had till that time appeared in the world; and was declared admiral of Holland, even by the advice of the prince of Orange. He in that character defeated a large Spanish fleet in 1630, and gained 32 other victories at sea; but was killed when under deck, in an engagement with the English in 1653. The states-general caused medals to be struck to his honour, and lamented him as one of the greatest heroes of their republic. Van Tromp, in the midst

midst of the greatest glory, constantly discovered a remarkable modesty; for he never assumed a higher character than that of a burgher, and that of being the father of the sailors.

TRONAGE, an ancient customary duty or toll, for weighing of wool. According to Fleta, *trona* is a beam to weigh with, mentioned in the stat. Westm. 2. cap. 25. And tronage was used for the weighing wool in a staple or public mart, by a common trona or beam; which for the tronage of wool in London, was fixed at Leaden-Hall. The mayor and commonalty of London are ordained keepers of the beams and weights for weighing merchants commodities, with power to assign clerks and porters, &c. of the great beam and balance; which weighing of goods and wares is called *tronage*; and no stranger shall buy any goods in London before they are weighed at the king's beam, on pain of forfeiture.

TRONE-WEIGHT, the most ancient of the different weights used in Scotland; and, though now forbidden by several statutes, is still used by many for home commodities, and that in a very irregular manner; for the pound varies in different places, and for different purposes, from 20 to 24 Dutch ounces. The common allowance is 21½ ounces for wool, 20⅝ for butter and cheese, 20 for tallow, lint, hemp, and hay. It is divided into 16 of its own ounces, and 16 pounds make a stone.

TROOP, a small body of horse or dragoons, about 50 or 60, sometimes more, sometimes less, commanded by a captain, lieutenant, cornet, quarter-master, and three corporals, who are the lowest officers of a troop.

TROPE. See ORATORY, N° 52—66.

TROPHONIUS's CAVE, or *Oracle*, in *Ancient Geography*, a cave near Lebadia in Bœotia, between Helicon and Chæronea (Strabo): so called from Trophonius, an enthusiastic diviner; who, descending into this cave, pretended to give answers and pronounce oracles; and was hence called *Jupiter Trophonius*. Such as went down to this cave never after smiled; hence the proverbial saying of a man who has lost his mirth, That he is come out of Trophonius's cave. Though Pausanias affirms that persons came out of the cave affected indeed with a stupor, but that they soon after recovered themselves. Dr Clarke found the cave choaked up with stones. See ORACLE.

TROPHY (*Tropæum*), among the ancients, a monument of victory.

TROPIC-BIRD. See PHAETON, ORNITHOLOGY *Index*.

TROPICS. See GEOGRAPHY.

TROUBADOURS, poets that flourished in Provence during the 12th century.

They wrote poems on love and gallantry; on the illustrious characters and remarkable events of the times; satires which were chiefly directed against the clergy and monks; and a few didactic pieces. The troubadours were great favourites in different courts, diffused a taste for their language and for poetry over Europe, which was about that time sunk in ignorance and rudeness; they disappeared in the 14th century. A history of the troubadours in 3 vols. 12mo, was begun by M. de Sainte Palaie, and finished by the abbé Millot. See MUSIC.

TROUGH, GALVANIC. See GALVANISM. For later discoveries in galvanic electricity, see ZINC.

TROVER, in *Law*, an action that a man hath against one that, having found any of his goods, refuseth to deliver them upon demand.

TROUT. See SALMO, ICHTHYOLOGY *Index*.

TROY. See TROJA.

TROY-Weight, one of the most ancient of the different kinds used in Britain. The ounce of this weight was brought from Grand Cairo in Egypt, about the time of the crusades into Europe, and first adopted in *Troyes*, a city of Champagne; whence the name.

The pound *English* Troy contains 12 ounces, or 5760 grains. It was formerly used for every purpose; and is still retained for weighing gold, silver, and jewels; for compounding medicines; for experiments in natural philosophy; and for comparing different weights with each other.

Scots TROY-Weight was established by James VI. in the year 1618, who enacted that only one weight should be used in Scotland, viz. the French Troy stone of 16 pounds, and 16 ounces in the pound. The pound contains 7600 grains, and is equal to 17 oz. 6 dr. avoirdupois. The cwt. or 112 lb. avoirdupois, contains only 103 lb. 2½ oz. of this weight, though generally reckoned equal to 104 lb. This weight is nearly, if not exactly, the same as that of Paris and Amsterdam; and is generally known by the name of *Dutch weight*. Though prohibited by the articles of union, it is still used in weighing iron, hemp, flax, most Dutch and Baltic goods, meal, butcher-meat, unwrought pewter and lead, and some other articles.

TRUE-LOVE. See PARIS, BOTANY.

TRUFFLES. See LYCOPERDON, BOTANY *Index*.

TRUMPET, a musical instrument, the most noble of all portable ones of the wind kind; used chiefly in war, among the cavalry, to direct them in the service. Each troop of cavalry has one. The cords of the trumpets are of crimson, mixed with the colours of the facings of the regiments.

As to the invention of the trumpet, some Greek historians ascribe it to the Tyrrhenians; but others, with greater probability, to the Egyptians; from whom it might have been transmitted to the Israelites. The trumpet was not in use among the Greeks at the time of the Trojan war; though it was in common use in the time of Homer. According to Potter (*Arch. Græc.* vol. ii. cap. 9.), before the invention of trumpets, the first signals of battles in primitive wars were lighted torches; to these succeeded shells of fishes, which were sounded like trumpets. And when the trumpet became common in military use, it may well be imagined to have served at first only as a rough and noisy signal of battle, like that at present in Abyssinia and New Zealand, and perhaps with only one sound. But even when more notes were produced from it, so noisy an instrument must have been an unfit accompanyment for the voice and poetry; so that it is probable the trumpet was the first solo instrument in use among the ancients.

TRUMPET, Articulate, comprehends both the *speaking* and the *hearing* trumpet, is by much the most valuable instrument, and has, in one of its forms, been used by people among whom we should hardly have expected to find such improvements.

That the *speaking trumpet*, of which the object is to increase the force of articulate sounds, should have been known to the ancient Greeks, can excite no wonder; and

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and therefore we easily admit the accounts which we read of the horn or trumpet, with which Alexander addressed his army, as well as of the whispering caverns of the Syracusan tyrant. But that the natives of Peru were acquainted with this instrument, will probably surprise many of our readers. The fact, however, seems incontrovertible.

In the History of the Order of Jesuits, published at Naples in 1601 by Beritaria, it is said, that in the year 1595 a small convent of that order in Peru, situated in a remote corner, was in danger of immediate destruction by famine. One evening the superior Father Samaniac implored the help of the cacique; next morning, on opening the gate of the monastery, he found it surrounded by a number of women each of whom carried a small basket of provisions. He returned thanks to heaven for having miraculously interposed, by inspiring the good people with pity for the distress of his friars. But when he expressed to them his wonder how they came all to be moved as if by mutual agreement with these benevolent sentiments, they told him it was no such thing; that they looked upon him and his countrymen as a pack of infernal magicians, who by their sorceries had enslaved the country, and had bewitched their good cacique, who hitherto had treated them with kindness and attention, as became a true worshipper of the sun; but that the preceding evening at sunset he had ordered the inhabitants of such and such villages, about six miles off, to come that morning with provisions to this nest of wizzards.

The superior asked them in what manner the governor had warned so many of them in so short a time, at such a distance from his own residence? They told him that it was by the trumpet; and that every person heard at their own door the distinct terms of the order. The father had heard nothing; but they told him that none heard the trumpet but the inhabitants of the villages to which it was directed. This is a piece of very curious information; but, after allowing a good deal to the exaggeration of the reverend Jesuits, it cannot, we think, be doubted but that the Peruvians actually possessed this stentorophonic art. For we may observe that the effect described in this narration resembles what *we now know* to be the effect of speaking trumpets, while it is unlike what the inventor of such a tale would naturally and ignorantly say. Till speaking trumpets were really known, we should expect the sound to be equally diffused on all sides, which is not the case; for it is much stronger in the line of the trumpet than in any direction very oblique to it.

About the middle of the 17th century, Athanasius Kircher turned his attention to the philosophy of sound, and in different works threw out many useful and scientific hints on the construction of speaking trumpets (see ACOUSTICS and KIRCHER); but his mathematical illustrations were so vague, and his own character of inattention and credulity so notorious, that for some time these works did not attract the notice to which they were well entitled.

About the year 1670, Sir Samuel Morland, a gentleman of great ingenuity, science, and order, took up the subject, and proposed as a question to the Royal Society of London, What is the best form for a speaking trumpet? which he called a stentorophonic horn. He accompanied his demand with an account of his own notions on the subject (which he acknowledged to be very vague and conjectural), and an exhibition of some instruments constructed according to his views. They were in general very large conical tubes, suddenly spreading at the very mouth to a greater width. Their effect was really wonderful. They were tried in St James's park; and his majesty K. Charles II. speaking in his ordinary colloquial pitch of voice through a trumpet only $5\frac{1}{2}$ feet long, was clearly and most distinctly heard at the distance of a thousand yards. Another person, selected we suppose for the loudness and distinctness of his voice, was perfectly understood at the distance of four miles and a half. The fame of this soon spread; Sir Samuel Morland's principles were refined, considering the novelty of the thing, and differ considerably from Father Kircher's. The aerial undulations, (for he speaks very accurately concerning the nature of sound) endeavour to diffuse themselves in spheres, but are stopped by the tube, and therefore reundulate towards the axis like waves from a bank, and meeting in the axis, they form a strong undulation a little farther advanced along the tube, which again spreads, is again reflected, and so on, till it arrives at the mouth of the tube greatly magnified, and then it is diffused through the open air in the same manner, as if all proceeded from a very sonorous point in the centre of the wide end of the trumpet. The author distinguishes with great judgement between the prodigious reinforcement of sound in a speaking trumpet and that in the musical trumpet, bugle-horn, conch-shell, &c.; and shows that the difference consists only in the violence of the first sonorous agitation, which can be produced by us only on a very small extent of surface. The mouth-piece diameter, therefore, of the musical trumpet must be very small, and the force of blast very considerable. Thus one strong but simple undulation will be excited, which must be subjected to the modifications of harmony, and will be augmented by using a conical tube (A). But a speaking trumpet must make no change on the nature of the first undulations; and each point of the mouth-piece must be equally considered as the centre of sonorous undulations, all of which must be reinforced in the same degree, otherwise all distinctness of articulation will be lost. The mouth-piece must therefore take in the whole of the mouth of the speaker.

When Sir Samuel Morland's trumpet came to be generally known on the continent, it was soon discovered that the speaker could be heard at a great distance only in the line of the trumpet; and this circumstance was by a Mr Cassegrain (*Journ. des Sçavans*, 1672, p. 131.) attributed to a defect in the principle of its construction, which he said was not according to the laws of sonorous undulations. He proposed a conoid formed by the revolution of a hyperbola round its assymptote as the best form. A Mr Hase of Wirtemberg, on the other hand, proposed a parabolic conoid, having the mouth of the speaker

(A) Accordingly the sound of the bugle horn, of the musical trumpet, or the French horn, is prodigiously loud, when we consider the small passage through which the moderate blast is sent by the trumpeter.

Trumpet speaker placed in the focus. In this construction he plainly went on the principle of a reflection similar to that of the rays of light; but this is by no means the case. The effect of the parabola will be to give one reflection, and in this all the circular undulations will be converted into plane waves, which are at right angles to the axis of the trumpet. But nothing hinders their subsequent diffusion; for it does not appear that the sound will be enforced, because the agitation of the particles on each wave is not augmented.

The subject is exceedingly difficult. We do not fully comprehend on what circumstance the affection or agitation of our organ, or simply of the membrana tympani, depends. A more violent agitation of the same air, that is, a wider oscillation of its particles, cannot fail to increase the impulse on this membrane. The point therefore is to find what concourse of feeble undulations will produce or be equivalent to a great one. The reasonings of all these restorers of the speaking trumpet are almost equally specious, and each point out some phenomenon which should characterise the principle of construction, and thus enable us to say which is most agreeable to the procedure of nature. Yet there is hardly any difference in the performance of trumpets of equal dimensions made after these different methods.

The propagation of light and of elastic undulations seem to require very different methods of management. Yet the ordinary phenomena of echoes are perfectly explicable by the acknowledged laws either of optics or acoustics; still however there are some phenomena of sound which are very unlike the genuine results of elastic undulations. If sounds are propagated spherically, then what comes into a room by a small hole should diffuse itself from that hole as round a centre, and it should be heard equally well at twelve feet distance from the hole in every direction. Yet it is very sensibly louder when the hearer is in the straight line drawn from the sonorous body through the hole. A person can judge of the direction of the sounding body with tolerable exactness. Cannon discharged from the different sides of a ship are very easily distinguished, which should not be the case by the Newtonian theory; for in this the two pulses on the ear should have no sensible difference.

The most important fact for our purpose is this: An echo from a small plane surface in the midst of an open field is not heard, unless we stand in such a situation that the angle of reflected sound may be equal to that of incidence. But by the usual theory of undulations, this small surface should become the centre of a new undulation, which should spread in all directions. If we make an analogous experiment on watery undulations, by placing a small flat surface so as to project a little above the water, and then drop in a small pebble at a distance, so as to raise one circular wave, we shall observe, that when this wave arrives at the projecting plane, it is disturbed by it, and this disturbance spreads from it on all sides. It is indeed sensibly stronger in that line which is drawn from it at equal angles with the line drawn to the place where the pebble was dropped. But in the case of sound, it is a fact, that if we go to a very small distance on either side of the line of reflection, we shall hear nothing.

Here then is a fact, that whatever may be the nature of the elastic undulations, sounds are reflected from a small plane in the same manner as light. We may avail ourselves of this fact as a mean for enforcing sound, though we cannot explain it in a satisfactory manner. We should expect from it an effect similar to the hearing of the original sound along with another original sound coming from the place from which this reflected sound diverges. If therefore the reflected sound or echo arrives at the ear in the same instant with the original sound, the effect will be doubled; or at least it will be the same with two simultaneous original sounds. Now we know that this is in some sense equivalent to a stronger sound. For it is a fact, that a number of voices uttering the same or equal sounds are heard at a much greater distance than a single voice. We cannot perhaps explain how this happens by mechanical laws, nor assign the exact proportion in which 10 voices exceed the effect of one voice; nor the proportion of the distances at which they seem equally loud. We may therefore, for the present, suppose that two equal voices at the same distance are twice as loud, three voices three times as loud, &c. Therefore, if by means of a speaking trumpet, we can make 10 equal echoes arrive at the ear at the same moment, we may suppose its effect to be to increase the audibility 10 times; and we may express this shortly, by calling the sound 10 times louder or more intense.

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But we cannot do this precisely. We cannot by any contrivance make the sound of a momentary snap, and those of its echoes, arrive at the ear in the same moment, because they come from different distances. But if the original noise be a continued sound, a man's voice, for example, uttering a continued uniform tone, the first echo may reach the ear at the same moment with the second vibration of the larynx; the second echo along with the third vibration, and so on. It is evident, that this will produce the same effect. The only difference will be, that the articulations of the voice will be made indistinct, if the echoes come from very different distances. Thus if a man pronounce the syllable *taw*, and the 10 successive echoes are made from places which are 10 feet farther off, the 10th part of a second (nearly) will intervene between hearing the first and the last. This will give it the sound of the syllable *thaw*, or perhaps *raw*, because *r* is the repetition of *t*. Something like this occurs when, standing at one end of a long line of soldiers, we hear the muskets of the whole line discharged in one instant. It seems to us the sound of a running fire.

The aim therefore in the construction of a speaking trumpet may be, to cause as many echoes as possible to reach a distant ear without any perceptible interval of time. This will give distinctness, and something equivalent to loudness. *Pure* loudness arises from the violence of the single aerial undulation. To increase this may be the aim in the construction of a trumpet; but we are not sufficiently acquainted with the mechanism of these undulations to bring this about with certainty and precision; whereas we can procure this accumulation of echoes without much trouble, since we know that echoes are, *in fact*, reflected like light. We can form a trumpet so that many of these lines of reflected sound shall pass through the place of the hearer. We are indebted to Mr Lambert of Berlin for this simple and popular view of the subject; and shall here give an abstract of his most ingenious Dissertation on Acoustic Instruments published in the Berlin Memoirs for 1763.

Sound

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Sound naturally spreads in all directions; but we know that echoes or reflected sounds proceed almost strictly in certain limited directions. If therefore we contrive a trumpet in such a way that the lines of echo shall be confined within a certain space, it is reasonable to suppose that the sound will become more audible in proportion as this diffusion is prevented. Therefore, if we can oblige a sound which, in the open air, would have diffused itself over a hemisphere, to keep within a cone of 120 degrees, we should expect it to be twice as audible within this cone. This will be accomplished, by making the reflections such that the lines of reflected sound shall be confined within this cone. *N. B.* We here suppose that nothing is lost in the reflection. Let us examine the effect of a cylindrical trumpet.

Plate DXXXIX. fig. 1.

Let the trumpet be a cylinder ABED, (fig. 1.), and let C be a sounding point in the axis. It is evident that all the sound in the cone BCE will go forward without any reflection. Let CM be any other line of sound, which we may for brevity's sake, call a *sonorous* or *phonic line*. Being reflected in the points M, N, O, P, it is evident that it will at last escape from the trumpet in a direction PQ, equally diverging from the axis with the line CM. The same must be true of every other sonorous line. Therefore the echoes will all diverge from the mouth of the trumpet in the same manner as they would have proceeded from C without any trumpet. Even supposing, therefore, that the echoes are as strong as the original sound, no advantage is gained by such a trumpet, but that of bringing the sound forward from C to *c*. This is quite trifling when the hearer is at a distance. Yet we see that sounds may be heard at a very great distance, at the end of long, narrow, cylindrical, or prismatical galleries. It is known that a voice may be distinctly heard at the distance of several hundred feet in the Roman aqueducts, whose sides are perfectly straight and smooth, being plastered with stucco. The smooth surface of the still water greatly contributes to this effect. Cylindrical or prismatical trumpets must therefore be rejected.

Let the trumpet be a cone BCA (fig. 2.), of which CN is the axis, DK a line perpendicular to the axis, and DFHI the path of a reflected sound in the plane of the axis. The last angle of reflection IHA is equal to the last angle of incidence FHC. The angle BFH, or its equal CFD, is equal to the angles FHD and FCH; that is, the angle of incidence CFD exceeds the next angle of incidence FHC by the angle FCD; that is, by the angle of the cone. In like manner, FDH exceeds CFD by the same angle FCD. Thus every succeeding angle, either of incidence or reflection, exceeds the next by the angle of the cone. Call the angle of the cone a, and let b be the first angle of incidence PDC. The second, or DFC, is $b-a$. The third, or FHC, is $b-2a$, &c.: and the nth angle of incidence or reflection is $b-na$, after n reflections. Since the angle diminishes by equal quantities at each subsequent reflection, it is plain, that whatever be the first angle of incidence, it may be exhausted by this diminution; namely, when n times a exceeds or is equal to b. Therefore to know how many reflections of a sound, whose first incidence has the inclination b, can be made in an infinitely extended cone, whose angle is a, divide b by a; the quotient will give the number n of reflections, and the remainder, if any, will be the last angle of incidence or reflection less than a. It is very plain, that when an angle of reflection IHA is equal to or less than the angle BCA of the cone, the reflected line HI will no more meet with the other side CB of the cone.

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We may here observe, that the greatest angle of incidence is a right angle, or 90°. This sound would be reflected back in the same line, and would be incident on the opposite side in an angle $=90^\circ-a$, &c.

Thus we see that a conical trumpet is well suited for confining the sound: for by prolonging it sufficiently, we can keep the lines of reflected sound wholly within the cone. And when it is not carried to such a length as to do this, when it allows the sounding line GH, for example, to escape without farther reflection, the divergency from the axis is less than the last angle of reflection BGH by half the angle BCA of the cone. Let us see what is the connection between the length and the angle of ultimate reflection.

We have sin. $\overline{b-a}$: sin. b = CD : CF, and CF $=$ CD $\times \frac{\text{sin. } b}{\text{sin. } \overline{b-a}}$, and sin. $\overline{b-2a}$: sin. $\overline{b-a}$ = CF : CH, and CH $=$ CF $\times \frac{\text{sin. } \overline{b-a}}{\text{sin. } \overline{b-2a}} =$ CD $\times \frac{\text{sin. } b}{\text{sin. } \overline{b-a}} \times \frac{\text{sin. } \overline{b-a}}{\text{sin. } \overline{b-2a}}, =$ CD $\times \frac{\text{sin. } b}{\text{sin. } \overline{b-2a}}$, &c.

Therefore if we suppose X to be the length which will give us n reflections, we shall have X $=$ CD $\times \frac{\text{sin. } b}{\text{sin. } \overline{b-na}}$. Hence we see that the length increases as the angle $\overline{b-na}$ diminishes; but is not infinite, unless na is equal to b. In this case, the immediately preceding angle of reflection must be a, because these angles have the common difference a. Therefore the last reflected sound was moving parallel to the opposite side of the cone, and cannot again meet it. But though we cannot assign the length which will give the nth reflection, we can give the length which will give the one immediately preceding, whose angle with the side of the cone is a. Let Y be this length. We have Y $=$ CD $\times \frac{\text{sin. } b}{\text{sin. } a}$. This length will allow every line of sound to be reflected as often, saving once, as if the tube were infinitely long. For suppose a sonorous line to be traced backwards, as if a sound entered the tube in the direction $i\,h$, and were reflected in the points h, f, d, d, D, the angles will be continually augmented by the constant angle a. But this augmentation can never go farther than $90^\circ+\frac{1}{2}a$. For if it reaches that value at D, for instance, the reflected line DK will be perpendicular to the axis CN; and the angle ADK will be equal to the angle DKB, and the sound will come out again. This remark is of importance on another account.

Now suppose the cone to be cut off at D by a plane perpendicular to the axis, KD will be the diameter of its mouth-piece; and if we suppose a mouth completely occupying this circle, and every point of the circle to be sonorous, the reflected sounds will proceed from it in the same manner as light would from a flame which completely occupies its area, and is reflected by the inside of the cone. The angle FDA will have the greatest possible sine when it is a right angle, and it never can be greater than ADK, which is $=90+\frac{1}{2}a$. And since between $90^\circ+\frac{1}{2}a$, and $90-\frac{1}{2}a$, there must fall some multiple of a; call this multiple b. Then, in order that every sound may be reflected as often as possible, saving once, we must make the length of it $X = CD \times \frac{S,b}{S,a}$.

Now since the angle of the cone is never made very great, never exceeding 10 or 12 degrees, b can never differ from 90 above a degree or two, and its sine cannot differ much from unity. Therefore X will be very nearly equal to $\frac{CD,}{S,a}$, which is also very nearly equal to $\frac{CD}{2S,\frac{1}{2}a}$; because a is small, and the sines of small arches are nearly equal and proportional to the arches themselves. There is even a small compensation of errors in this formula. For as the sine of 90° is somewhat too large, which would give X too great, $2S,\frac{1}{2}a$ is also larger than the sine of a. Thus let a be 12°: then the nearest multiple of a is 84 or 96°, both of which are as far removed as possible from 90°, and the error is as great as possible, and is nearly $\frac{1}{160}$th of the whole.

This approximation gives us a very simple construction. Let CM be the required length of the trumpet, and draw ML perpendicular to the axis in O. It is evident that S, MCO : rad. = MO : CM, and CM; or $X=\frac{MO}{S,\frac{1}{2}a}=\frac{LM}{2S,\frac{1}{2}a}$, but $X=\frac{CD}{2S,\frac{1}{2}a}$, and therefore LM is equal to CD.

If therefore the cone be of such a length, that its diameter at the mouth is equal to the length of the part cut off, every line of sound will have at least as many reflections, save one, as if the cone were infinitely long; and the last reflected line will either be parallel to the opposite side of the cone, or lie nearer the axis than this parallel; consequently such a cone will confine all the reflected sounds within a cone whose angle is $2a$, and will augment the sound in the proportion of the spherical base of this cone to a complete hemispherical surface. Describe the circle DKT round C, and making DT an arch of 90, draw the chord DT. Then since the circles described with the radii DK, DT, are equal to the spherical surfaces generated by the revolution of the arches DK and DKT round the axis CD, the sound will be condensed in the proportion of DK^2 to DT^2.

This appears to be the best general rule for constructing the instrument; for, to procure another reflection, the tube must be prodigiously lengthened, and we cannot suppose that one reflection more will add greatly to its power.

It appears, too, that the length depends chiefly on the angle of the cone; for the mouth-piece may be considered as nearly a fixed quantity. It must be of a size to admit the mouth when speaking with force and without constraint. About an inch and a half may be fixed on for its diameter. When therefore we propose to confine the sound to a cone of twice the angle of the trumpet, the whole is determined by that angle. For since in this case LM is equal to CD, we have DK : CD = LM (or CD) : CM and $CM=\frac{CD^2}{DK}$.

$$\begin{array}{lll} \text{But} & 2S,\tfrac{1}{2}a : 1 = DK : CD, \\ \text{and} & 2S,\tfrac{1}{2}a : 1 = CD : CM ; \\ \text{therefore} & 4S,^2\tfrac{1}{2}a : 1 = DK : CM, \end{array}$$

$$\text{And} \quad CM=\frac{DK}{4S,^2\frac{1}{2}a}, =\frac{DK}{S,^2a} \text{ very nearly.}$$

And since DK is an inch and a half, we get the length in inches, counted from the apex of the cone $=\frac{1\frac{1}{2}}{S,^2a}$, or $\frac{3}{2S,^2a}$. From this we must cut off the part CD, which is $=\frac{DK}{S,\frac{1}{2}a}$, or very nearly $\frac{DK}{S,a}$, or $\frac{3}{2S,a}$, measured in inches, and we must make the mouth of the same width $\frac{3}{2S,a}$.

On the other hand, if the length of the trumpet is fixed on, we can determine the angle of the cone. For let the length (reckoned from C) be L; we have $2S,^2a=\frac{3}{L}$, or $S,^2a=\frac{3}{2L}$, and $S,a=\sqrt{\frac{3}{2L}}$.

Thus let 6 feet or 72 inches be chosen for the length of the cone, we have $S,a=\sqrt{\frac{3}{144}}=\sqrt{\frac{1}{48}}$, $=014434$ $=$ sin. $8^\circ 17'$ for the angle of the cone; and the width at the mouth is $\frac{3}{2,S,a}=10{,}4$ inches. This being taken from 72, leaves 61,6 inches for the length of the trumpet.

And since this trumpet confines the reflected sounds to a cone of $16^\circ 34'$, we have its magnifying power $=\frac{DT^2}{DK^2}$, $=\frac{\frac{1}{2}DT^2}{\frac{1}{2}DK^2}=\frac{S,^2 45^\circ}{S,^2 4^\circ 8'\frac{1}{2}}=96$ nearly. It therefore condenses the sound about 96 times; and if the distribution were uniform, it would be heard $\sqrt{96}$, or nearly 10 times farther off. For the loudness of sounds is supposed to be inversely as the square of the distance from the centre of undulation.

But before we can pronounce with precision on the performance of a speaking trumpet, we must examine into the manner in which the reflected sounds are distributed over the space in which they are all confined.

Let BKDA (fig. 3.) be the section of a conical trumpet by a plane through the axis; let C be the vertex of the cone, and CW its axis; let TKV be the section of a sphere, having its centre in the vertex of the cone; and let P be a sonorous point on the surface of the sphere, and P *a f e l* the path of a line of sound lying in the plane of the section. Fig. 3.

In the great circle of the sphere take KQ=KP, DR =DQ, and KS=KR. Draw QB *h*; also draw Q *d n* parallel to DA; and draw PB, P *d*, PA.

1. Then it is evident that all the lines drawn from P, within the cone APB, proceed without reflection, and are diffused as if no trumpet had been used.

2. All

Trumpet.

2. All the sonorous lines which fall from P on KB are reflected from it as if they had come from Q.

3. All the sonorous lines between BP and *d* P have suffered but one reflection; for *d n* will no more meet DAA′ so as to be reflected again.

4. All the lines which have been reflected from KB, and afterwards from DA, proceed as if they had come from R. For the lines reflected from KB proceed as if they had come from Q; and lines coming from Q and reflected by DA, proceed as if they had come from R. Therefore draw RA *o*, and also draw R*g m* parallel to KB, and draw Q *c* A *q*, Q *b g*, P *c*, and P *b*. Then,

5. All the lines between *b* P and *c* P have been twice reflected.

Again, draw SB *p*, B *r* R, *r u* Q, S *x* A, R*y x*, Q*z y*.

6. All the lines between *u* P and *z* P have suffered three reflections.

Draw the tangents TA *t*, VB *v*, crossing the axis in W.

7. The whole sounds will be propagated within the cone *v* W *t*. For to every sonorous point in the line KD there corresponds a point similar to Q, regulating the first reflection from KB; and a point similar to R, regulating the second reflection from DA; and a point S regulating the third reflection from KB, &c. And similar points will be found regulating the first reflection from DA, the second from KB, and the third from DA, &c.; and lines drawn from all these through A and B must lie within the tangents TA and VB.

8. Thus the centres of reflection of all the sonorous lines which lie in planes passing through the axis, will be found in the surface of this sphere; and it may be considered as a sonorous sphere, whose sounds first concentrate in W, and are then diffused in the cone *v* W *t*.

It may be demonstrated nearly in the same manner, that the sonorous lines which proceed from P, but not in the plane passing through the axis, also proceed, after various reflections, as if they had come from points in the surface of the same sphere. The only difference in the demonstration is, that the centres Q, R, S of the successive reflections are not in one plane, but in a spiral line winding round the surface of the sphere according to fixed laws. The foregoing conclusions are therefore general for all the sounds which come in all directions from every point in the area of the mouth piece.

Thus it appears, that a conical trumpet is well fitted for increasing the force of sounds by diminishing their final divergence. For had the speaker's mouth been in the open air, the sounds which are now confined within the cone *v* W *t* would have been diffused over a hemisphere: and we see that prolonging the trumpet must confine the sounds still more, because this will make the angle BWA still smaller; a longer tube must also occasion more reflections, and consequently send more sonorous undulations to the ear at a distance placed within the cone *v* W *t*.

We have now obtained a very connected view of the whole effect of a conical trumpet. It is the same as if the whole segment TKDV were sounding, every part of it with an intensity proportional to the density of the points Q, R, S, &c. corresponding to the different points P of the mouth-piece. It is easy to see that this cannot be uniform, but must be much rarer towards the margin of the segment. It would require a good deal of discussion to show the density of these fictitious sounding points; and we shall content ourselves with giving a very palpable view of the distribution of the sonorous rays, or the density (so to speak) of the echoes, in the different situations in which a hearer may be placed.

Trumpet.

We may observe, in the mean time, that this substitution of a sounding sphere for the sounding mouth-piece has an exact parallel in OPTICS, by which it will be greatly illustrated. Suppose the cone BKDA (fig. 3.) to be a tube polished in the inside, fixed in a wall B *a*, perforated in BA, and that the mouth-piece DK is occupied completely by a flat flame. The effect of this on a spectator will be the same, if he is properly placed in the axis, as if he were looking at a flame as big as the whole sphere. This is very evident. Fig. 3.

It is easy to see that the line *l e* S is equal to the line *l e f a* P; therefore the reflected sounds also come to the ear in the same moments as if they had come from their respective points on the surface of the substituted sphere. Unless, therefore, this sphere be enormously large, the distinctness of articulation will not be sensibly affected, because the interval between the arrival of the different echoes of the same snap will be insensible.

Our limits oblige us to content ourselves with exhibiting this evident similarity of the progress of echo from the surface of this phonic sphere, to the progress of light from the same luminous sphere shining through a hole of which the diameter is AB. The direct investigation of the intensity of the sound in different directions and distances would take up much room, and give no clearer conception of the thing. The intensity of the sound in any point is precisely similar to the intensity of the illumination of the same point; and this is proportional to the portion of the luminous surface seen from this point through the hole directly, and to the square of the distance inversely. The intelligent reader will acquire a distinct conception of this matter from fig. 4. which represents the distribution of the sonorous lines, and by consequence the degree of loudness which may be expected in the different situations of the hearer.

As we have already observed, the effect of the cone of the trumpet is perfectly analogous to the reflection of light from a polished concave, conical mirror. Such an instrument would be equally fitted for illuminating a distant object. We imagine that these would be much more powerful than the spherical or even parabolic mirrors commonly used for this purpose. These last, having the candle in the focus, also send forward a cylinder of light of equal width with the mirror. But it is well known, that oblique reflections are prodigiously more vivid than those made at greater angles. Where the inclination of the reflected light to the plane of the mirror does not exceed eight or ten degrees, it reflects about three-fourths of the light which falls on it. But when the inclination is 80, it does not reflect one-fourth part.

We may also observe, that the density of the reflected sounds by the conical trumpet ABC (fig. 4.) is precisely similar to that of the illumination produced by a luminous sphere TDV, shining through a hole AB. There will be a space circumscribed by the cone formed by the lines TB *t* and VA *v*, which is uniformly illuminated by the whole sphere (or rather by the segment TDV), and on each side there is a space illuminated by a Fig. 4.

Fig. 1.

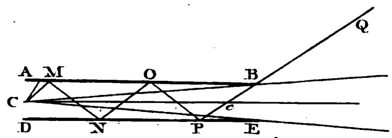


Fig. 2.

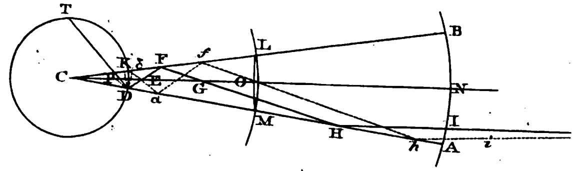


Fig. 3.

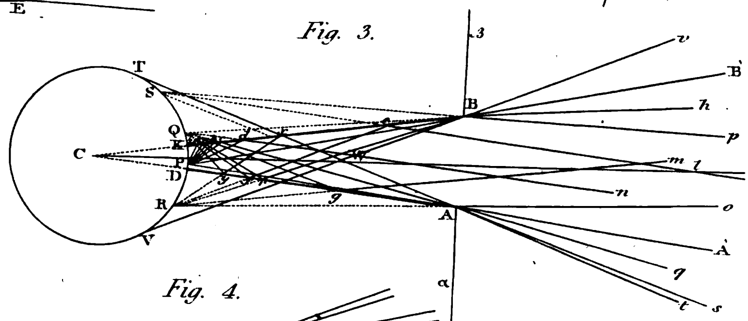


Fig. 4.

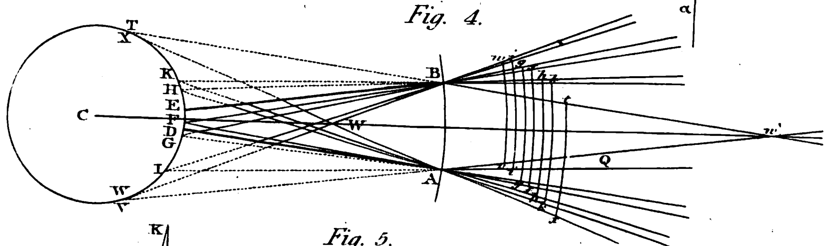


Fig. 5.

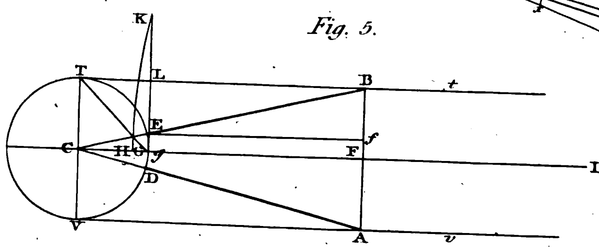


Fig. 7.

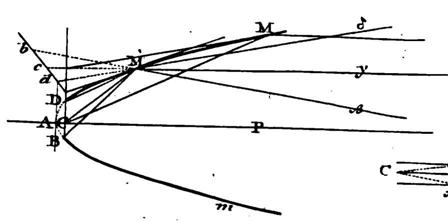
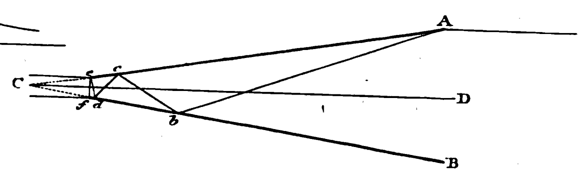


Fig. 6.



W. Train Sculp.t

Trumpet.

a part of it only, and the illumination gradually decreases towards the borders. A spectator placed much out of the axis, and looking through the hole AB, may not see the whole sphere. In like manner, he will not hear the whole sounding sphere: He may be so far from the axis as neither to see nor hear any part of it.

Assisting our imagination by this comparison, we perceive that beyond the point w' there is no place where *all* the reflected sounds are heard. Therefore, in order to preserve the magnifying power of the trumpet at any distance, it is necessary to make the mouth as wide as the sonorous sphere. Nay, even this would be an imperfect instrument, because its power would be confined to a very narrow space; and if it be not accurately pointed to the person listening, its power will be greatly diminished. And we may observe, by the way, that we derive from this circumstance a strong confirmation of the justness of Mr Lambert's principles; for the effects of speaking trumpets are really observed to be limited in the way here described.—Parabolic trumpets have been made, and they fortify the sound not only in the cylindrical space in the direction of the axis, but also on each side of it, which should not have been the case had their effect depended only on the undulations formed by the parabola in planes perpendicular to the axis. But to proceed.

Fig. 5. Let BCA (fig. 5.) be the cone, ED the mouth-piece, TEDV the equivalent sonorous sphere, and TBAV the circumscribed cylinder. Then CA or CB is the length of cone that is necessary for maintaining the magnifying power at all distances. We have two conditions to be fulfilled. The diameter ED of the mouth-piece must be of a certain fixed magnitude, and the diameter AB of the outer end must be equal to that of the equivalent sonorous sphere. These conditions determine all the dimensions of the trumpet and its magnifying power. And, first, with respect to the dimensions of the trumpet.

The similarity of the triangles ECG and BCF gives $CG : ED = CF : AB$; but $CG = BF, = \frac{1}{2} AB$, and $CF = CG + GF, = GF + \frac{1}{2} AB$; therefore $\frac{1}{2} AB : ED = GF + \frac{1}{2} AB : AB$, and $AB : ED = 2\,GF + AB : AB$; therefore $2\,GF \times ED + AB \times ED = AB^2$, and $2\,GF \times ED = AB^2, - AB \times ED, = AB \times \overline{AB - ED}$,

and $GF = \dfrac{AB \times \overline{AB - ED}}{2\,ED}$. And, on the other hand, because $AB^2 - EB \times AD = 2\,GF \times ED$, we have $AB^2 - AB \times ED + \frac{1}{4} ED^2 = 2\,GF \times ED + \frac{1}{4} ED^2$, or $\overline{AB - \frac{1}{2} ED}^2 = 2\,GF \times ED + \frac{1}{4} ED^2$, and $AB = \sqrt{2\,GF \times ED + \frac{1}{4} ED^2} + \frac{1}{2} ED$.

Let x represent the length of the trumpet, y the diameter at the great end, and m the diameter of the mouth-piece. Then $x = \dfrac{y \times \overline{y - m}}{2\,m}$, and $y = \sqrt{2xm + \frac{1}{4} m^2} + \frac{1}{2} m$.

Thus the length and the great diameter may be had reciprocally. The useful case in practice is to find the diameter for a proposed length, which is gotten by the last equation.

Now if we take all the dimensions in inches, and fix m at an inch and a half, we have $2\,x\,m = 3\,x$, and $\frac{1}{4} m^2 = 0{,}5625$, and $\frac{1}{2} m = 0{,}75$; so that our equation becomes $y = \sqrt{3x + 0{,}5625} + 0{,}75$. The following table gives the dimensions of a sufficient variety of trumpets. The first column is the length of the trumpet in feet; the second column is the diameter of the mouth in inches; the third column is the number of times that it magnifies the sound; and the fourth column is the number of times that it increases the distance at which a man may be distinctly heard by its means; the fifth contains the angle of the cone.

GF feet.	AB. Inches.	Magnifying.	Extending.	ACB.
				° ′
1	6.8	42.6	6.5	24.53
2	9.3	77.8	8.8	18.23
3	11.2	112.4	10.6	15.18
4	12.8	146.6	12.1	13.24
5	14.2	180.4	13.4	12.04
6	15.5	214.2	14.6	11.05
7	16.6	247.7	15.7	10.18
8	17.7	281.3	16.8	9.40
9	18.8	314.6	17.7	9.08
10	19.8	347.7	18.6	8.42
11	20.7	380.9	19.5	8.18
12	21.5	414.6	20.4	7.58
15	24.	513.6	22.7	7.09
18	26.2	612.3	24.7	6.33
21	28.3	711.2	26.6	6.05
24	30.2	810.1	28.5	5.42
ED in all is = 1.5				

The two last columns are constructed on the following considerations: We conceive the hearer placed within the cylindrical space whose diameter is BA. In this situation he receives an echo coming apparently from the whole surface TGV; and we account the effect of the trumpet as equivalent to the united voices of as many mouths as would cover this surface. Therefore the quotient obtained by dividing the surface of the hemisphere by that of the mouth-piece will express the magnifying power of the trumpet. If the chords g E, g T, be drawn, we know that the spherical surfaces T g V, E g D, are respectively equal to the circles described with the radii T g, E g, and are therefore as T g^2 and E g^2. Therefore the audibility of the trumpet, when compared with a single voice, may be expressed by $\dfrac{T\,g^2}{E\,g^2}$. Now the ratio of T g^2 to E g^2 is easily obtained. For if E f be drawn parallel to the axis, it is plain that $B\,f = \dfrac{BA - ED}{2}$, and that E f is to f B as radius to the tangent of BCF; which angle we may call a. Therefore $\tan.\ a = \dfrac{y - m}{2\,x}$, and thus we obtain the angle a. But if the radius CE be accounted 1, T g is $= \sqrt{2}$, and E g is $= 2 \sin. \frac{a}{2}$. Therefore $\dfrac{T\,g}{E\,g} = \dfrac{\sqrt{2}}{2 \sin. \frac{a}{2}}$, and the magnifying power of the trumpet is $= \dfrac{2}{4 \sin.^2 \frac{a}{2}}$, Trumpet. $= \frac{1}{2 \sin.^2 \frac{a}{2}}$. The numbers, therefore, in the third column of the table are each $= \frac{1}{2 \sin.^2 \frac{a}{2}}$.

But the more usual way of conceiving the power of the trumpet is, by considering how much farther it will enable us to hear a voice equally well. Now we suppose that the audibility of sounds varies in the inverse duplicate ratio of the distance. Therefore if the distance d, at which a man may be distinctly heard, be increased to z, in the proportion of EG to Tg, the sound will be less audible, in the proportion of Tg^2 to EG^2. Therefore the trumpet will be as well heard at the distance z as the simple voice is heard at the distance d. Therefore $\frac{z}{d}$ will express the *extending power* of the trumpet, which is therefore $= \frac{\sqrt{2}}{2 \sin. \frac{a}{2}}$. In this manner were the numbers computed for the fourth column of the table.

When the angle BCA is small, which is always the case in speaking trumpets, we may, without any sensible error, consider EG as $= \frac{ED}{2}, = \frac{m}{2}$. And TG=TC $\times \sqrt{2}, = \frac{AB}{2}\sqrt{2} = \frac{AB}{\sqrt{2}} = \frac{y}{\sqrt{2}}$. This gives a very easy computation of the extending and magnifying powers of the trumpet.

The extending power is $= \sqrt{2}\,\frac{y}{m}$.

The magnifying power is $= 2\,\frac{y^2}{m^2}$.

We may also easily deduce from the premises, that if the mouth-piece be an inch and a half in diameter, and the length x be measured in inches, the extending power is very nearly $= \sqrt{\frac{8}{5}x}$ and the magnifying power $= \frac{8}{5}x$.

An inconvenience still attends the trumpet of this construction. Its complete audibility is confined to the cylindrical space in the direction of the axis, and it is more faintly heard on each side of it. This obliges us to direct the trumpet very exactly to the spot where we wish it to be heard. This is confirmed by all the accounts we have of the performance of great speaking trumpets. It is evident, that by lengthening the trumpet, and therefore enlarging its mouth, we make the lines TB t and VA v expand (fig. 4.); and therefore it will not be so difficult to direct the trumpet.

Fig. 4.

But even this is confined within the limits of a few degrees. Even if the trumpet were continued without end, the sounds cannot be reinforced in a wider space than the cone of the trumpet. But it is always advantageous to increase its length; for this makes the extreme tangents embrace a greater portion of the sonorous sphere, and thus increases the sound in the space where it is all reflected. And the limiting tangents TB, VA, expand still more, and thus the space of full effect is increased. But either of these augmentations is very small in comparison of the augmentation of size. If the trumpet of fig. 5. were made an hundred times longer, its power would not be increased one half.

Trumpet.

We need not therefore aim at much more than to produce a cylindrical space of full effect; and this will always be done by the preceding rules, or table of constructions. We may give the trumpet a third or a fourth part more length, in order to spread a little the space of its full effect, and thereby make it more easily directed to the intended object. But in doing this we must be careful to increase the diameter of the mouth as much as we increase the length; otherwise we produce the very opposite effect, and make the trumpet greatly inferior to a shorter one, at all distances beyond a certain point. For by increasing the length while the part CG remains the same, we cause the tangents TB and VA to meet on some distant point, beyond which the sound diffuses prodigiously. The construction of a speaking trumpet is therefore a problem of some nicety; and as the trials are always made at some considerable distance, it may frequently happen that a trumpet which is not heard at a mile's distance, may be made very audible two miles off by cutting off a piece at its wide end.

After this minute consideration of the conical trumpet, we might proceed to consider those of other forms. In particular, the hyperbolic, proposed by Cassegrain, and the parabolic, proposed by Haase, seem to merit consideration. But if we examine them merely as reflectors of echoes, we shall find them inferior to the conical.

With respect to the hyperbolic trumpet, its inaptitude is evident at first sight. For it must dissipate the echoes more than a conical trumpet. Indeed Mr Cassegrain proceeds on quite different principles, depending on the mechanism of the aerial undulations: his aim was to increase the agitation in each pulse, so that it may make a more forcible impulse on the ear. But we are too imperfectly acquainted with this subject to decide *à priori*; and experience shows that the hyperbola is not a good form.

With respect to the parabolic trumpet, it is certain that if the mouth-piece were but a point, it would produce the most favourable reflection of all the sounds; for they would all proceed parallel to the axis. But every point of an open mouth must be considered as a centre of sound, and none of it must be kept out of the trumpet. If this be all admitted, it will be found that a conical trumpet, made by the preceding rules, will dissipate the reflected sounds much less than the parabolic.

Thus far have we proceeded on the fair consequences of the well known fact, that echoes are reflected in the same manner as light, without engaging in the intricate investigation of aerial undulations. Whoever considers the Newtonian theory of the propagation of sound with intelligence and attention, will see that it is demonstrated solely in the case of a single row of particles; and that all the general corollaries respecting the lateral diffusion of the elastic undulations are little more than sagacious guesses, every way worthy of the illustrious author, and beautifully confirmed by what we can most distinctly and accurately observe in the circular waves on the surface of still water. But they are by no means fit for becoming the foundation of any doctrine which lays the smallest claim to the title of accurate science. We really know

Trumpet. know exceedingly little of the theory of aerial undulations; and the conformity of the phenomena of sound to these guesses of Sir Isaac Newton has always been a matter of wonder to every eminent and candid mathematician: and no other should pretend to judge of the matter. This wonder has always been acknowledged by Daniel Bernoulli; and he is the only person who has made any addition to the science of sounds that is worth mentioning. For such we must always esteem his doctrine of the secondary undulations of musical cords, and the secondary pulses of air in pipes. Nothing therefore is more unwarrantable, or more plainly shows the precipitant presumption of modern sciolists, than the familiar use of the general theory of aerial undulations in their attempts to explain the abstruse phenomena of nature (such as the communication of sensation from the organ to the sensorium by the vibrations of a nervous fluid, the reciprocal communication of the volitions from the sensorium to the muscle, nay, the whole phenomena of mind), by vibrations and vibratiunculæ.

Such attempts equally betray ignorance, presumption, and meanness of soul. Ignorance of the extent to which the Newtonian theory may be logically carried, is the necessary consequence of ignorance of the theory itself. It is presumption to apply it to the phenomena of the intellectual world; and surely he has an abject soul who hugs and cherishes the humble thought, that his mind is an undulating fluid, and that its all-grasping comprehension, and all its delightful emotions, are nothing more than an etherial tune.—"Pol me occidistis amentes." This whim is older than Hartley: It may be found in Robinet's *Systeme de la Nature*. This by the bye made its first appearance as a discourse delivered by Brother Orateur in the lodge of the grand Orient at Lyons; from which source have proceeded all the cosmopolitical societies in Europe, and that illumination by which reason is to triumph over revelation, and liberty and equality over civil government. We crave pardon of our readers for this ebullition of spleen; and we hope for it from all those who can read Newton, and who esteem his modesty.

Those who have endeavoured to improve the speaking trumpet on mechanical principles, have generally aimed at increasing the violence of the elastic undulations, that that they may make a more forcible impulse on the ear. This is the object in view in the parabolic trumpet. All the undulations are converted into others which are in planes perpendicular to the axis of the instrument; so that the same little mass of air is agitated again and again in the same direction. From this it is obvious to conclude, that the total agitation will be more violent. But, in the first place, these violent agitations must diffuse themselves laterally as soon as they get out of the trumpet, and thus be weakened, in a proportion that is perhaps impossible for the most expert analyst to determine. But, moreover, we are not sufficiently acquainted with the mechanism of the very first agitations, to be able to perceive what conformation of the trumpet will cause the reflected undulations to increase the first undulations, or to check them. For it must happen, during the production of a continued sound in a trumpet, that a parcel of air, which is in a state of progressive agitation, as it makes a pulse of one sound, may be in a state of retrograde agitation, as it is part of a pulse of air producing another sound. We cannot (at least no mathematician has yet done it) discriminate, and then combine these agitations, with the intelligence and precision that are necessary for enabling us to say what is the ultimate accumulated effect. Mr Lambert therefore did wisely in abstaining from this intricate investigation; and we are highly obliged to him for deducing such a body of demonstrable doctrine from the acknowledged, but ill understood, fact of the reflection of echoes. Trumpet.

We know that two sounds actually cross each other without any mutual disturbance; for we can hear either of them distinctly, provided the other is not so loud as to stun our ears, in the same manner as the glare of the sun dazzles our eyes. We may therefore depend on all the consequences which are legitimately deduced from this fact, in the same manner as we depend on the science of catoptrics, which is all deduced from a fact perfectly similar and as little understood.

But the preceding propositions by no means explain or comprehend all the reinforcement of sound which is really obtained by means of a speaking trumpet. In the first place, although we cannot tell in what degree the aerial undulations are increased, we cannot doubt that the reflections which are made in directions which do not greatly deviate from the axis, do really increase the agitation of the particles of air. We see a thing perfectly similar to this in the waves on water. Take a long slip of lead, about two inches broad, and having bent it into the form of a parabola, set it into a large flat trough, in which the water is about an inch deep. Let a quick succession of small drops of water fall precisely on the focus of the parabola. We shall see the circular waves proceeding from the focus all converted into waves perpendicular to the axis, and we shall frequently see these straight waves considerably augmented in their height and force. We say generally, for we have sometimes observed that these reflected waves were not sensibly stronger than the circular or original waves. We do not exactly know to what this difference must be ascribed: we are disposed to attribute it to the frequency of the drops. This may be such, that the interval of time between each drop is precisely equal, or at least commensurable, to the time in which the waves run over their own breadth. This is a pretty experiment; and the ingenious mechanician may make others of the same kind which will greatly illustrate several difficult points in the science of sounds. We may conclude in general that the reflection of sounds, in a trumpet of the usual shapes, is accompanied by a real increase of the aerial agitations; and in some particular cases we find the sounds prodigiously increased. Thus, when we blow through a musical trumpet, and allow the air to take that uniform undulation which can be best maintained in it, namely, that which produces its musical tone, where the whole tube contains but one or two undulations, the agitation of a particle must then be very great, and it must describe a very considerable line in its oscillations. When we suit our blast in such a manner as to continue this note, that is, this undulation, we are certain that the subsequent agitations conspire with the preceding agitation, and augment it. And accordingly we find that the sound is increased to a prodigious degree. A cor de chasse, or a bugle horn, when properly winded, will almost deafen the ear; and yet the exertion is a mere nothing in comparison with what we make when bellowing with all

Trumpet.

our force, but with not the tenth part of the noise. We also know, that if we speak through a speaking trumpet in the key which corresponds with its dimensions, it is much more audible than when we speak in a different pitch. These observations show, that the loudness of a speaking trumpet arises from something more than the sole reflection of echoes considered by Mr Lambert—the very echoes are rendered louder.

In the next place, the sounds are increased by the vibrations of the trumpet itself. The elastic matter of the trumpet is thrown into tremors by the undulations which proceed from the mouth-piece. These tremors produce pulses in the contiguous air, both in the inside of the trumpet and on that which surrounds it. These undulations within the trumpet produce original sounds, which are added to the reflected sounds: for the tremor continues for some little time, perhaps the time of three or four or more pulses. This must increase the loudness of the subsequent pulses. We cannot say to what degree, because we do not know the force of the tremor which the part of the trumpet acquires: but we know that these sounds will not be magnified by the trumpet to the same degree as if they had come from the mouth-piece; for they are reflected as if they had come from the surface of a sphere which passes through the agitated point of the trumpet. In short, they are magnified only by that part of the trumpet which lies without them. The whole sounds of this kind, therefore, proceed as if they came from a number of concentric spherical surfaces, or from a solid sphere, whose diameter is twice the length of the trumpet cone.

All these agitations arising from the tremors of the trumpet tend greatly to hurt the distinctness of articulation; because, coming from different points of a large sphere, they arrive at the ear in a sensible succession; and thus change a momentary articulation to a lengthened sound, and give the appearance of a number of voices uttering the same words in succession. It is in this way, that, when we clap our hands together near a long rail, we get an echo from each post, which produces a chirping sound of some continuance. For these reasons it is found advantageous to check all tremors of the trumpet by wrapping it up in woollen lists. This is also necessary in the musical trumpet.

With respect to the undulations produced by the tremors of the trumpet in the air contiguous to its outside, they also hurt the articulation. At any rate, this is so much of the sonorous momentum uselessly employed; because they are diffused like common sounds, and receive no augmentation from the trumpet.

Hearing trumpet.

It is evident, that this instrument may be used (and accordingly was so) for aiding the hearing; for the sonorous lines are reflected in either direction. We know that all tapering cavities greatly increase external noises; and we observe the brutes prick up their ears when they want to hear uncertain or faint sounds. They turn them in such directions as are best suited for the reflection of the sound from the quarter whence the animal imagines that it comes.

Let us apply Mr Lambert's principle to this very interesting case, and examine whether it be possible to assist dull hearing in like manner as the optician has assisted imperfect sight.

The subject is greatly simplified by the circumstances of the case; for the sounds to which we listen generally come in nearly one direction, and all that we have to do is to produce a constipation of them. And we may conclude, that the audibility will be proportional to this constipation.

Therefore let ACB, fig. 6. be the cone, and CD its axis. The sound may be conceived as coming in the direction RA, parallel to the axis, and to be reflected in the points A, *b*, *c*, *d*, *e*, till the angle of incidence increases to 90°; after which the subsequent reflections send the sound out again. We must therefore cut off a part of the cone; and, because the lines increase their angle of incidence at each reflection, it will be proper to make the angle of the cone an aliquot part of 90°, that the least incidence may amount precisely to that quantity. What part of the cone should be cut off may be determined by the former principles. Call the angle ACD, a. We have $Ce = \frac{CA \cdot \sin.\, a}{\sin.\, (2n+1)\, a}$, when the sound gets the last useful reflection. Then we have the diameter of the mouth $AB = 2\, CA \cdot \sin.\, a$, and that of the other end $ef = Ce \cdot 2 \sin.\, a$. Therefore the sounds will be constipated in the ratio of CA^2 to Ce^2, and the trumpet will bring the speaker nearer in the ratio of CA to C*e*.

Fig. 6.

When the lines of reflected sound are thus brought together, they may be received into a small pipe perfectly cylindrical, which may be inserted into the external ear. This will not change their angles of inclination to the axis nor their density. It may be convenient to make the internal diameter of this pipe $\frac{1}{3}$ of an inch. Therefore $Ce \cdot \sin.\, a$ is $= \frac{1}{6}$ of an inch. This circumstance, in conjunction with the magnifying power proposed, determines the other dimensions of the hearing trumpet. For $Ce = \frac{1}{6 \sin.\, a} = \frac{CA \cdot \sin.\, a}{\sin.\, (2n+1)\, a}$, and $CA = \frac{\sin.\, (2n+1\, a)}{6 \sin.^2\, a}$.

Thus the relation of the angle of the cone and the length of the instrument is ascertained, and the sound is brought nearer in the ratio of CA to C*e*, or of sin. $(2n+1)\, a$ to sin. a. And seeing that we found it proper to make $(2n+1)\, a = 90°$, we obtain this very simple analogy, $1 : \sin.\, a = CA : Ce$. And the sine of $\frac{1}{2}$ the angle of the cone is to radius as 1 to the approximating power of the instrument.

Thus let it be required that the sound may be as audible as if the voice were 12 times nearer. This gives $\frac{CA}{Ce} = 12$. This gives $\sin.\, a = \frac{1}{12}$, and $a = 4°\, 47'$, and the angle of the cone $= 9.34$. Then $CA = \frac{1}{6 \sin.^2\, a} = \frac{1}{6 \frac{1}{144}} = \frac{144}{6}, = 24$. Therefore the length of the cone is 24 inches. From this take $Ce = \frac{CA}{12} = 2$, and the length of the trumpet is 22 inches. The diameter at the mouth is $2\, Ce, = 4$ inches. With this instrument one voice should be as loud as 144.

If it were required to approximate the sound only four times, making it 16 times stronger than the natural voice

Trumpet. voice at the same distance, the angle ACB must be 29°; A e must be 2 inches, AB must be $1\frac{1}{3}$d inches, and ef must be $\frac{1}{3}$d of an inch.

It is easy to see, that when the size of the ear-end is the same in all, the diameters at the outer end are proportional to the approximating powers, and the lengths of the cones are proportional to the magnifying powers.

We shall find the parabolic conoid the preferable shape for an acoustic trumpet; because as the sounds come into the instrument in a direction parallel to the axis, they are reflected so as to pass through the focus. The parabolic conoid must therefore be cut off through the focus, that the sounds may not go out again by the subsequent reflections; and they must be received into a cylindrical pipe of one-third of an inch in diameter. Therefore the parameter of this parabola is one-sixth of an inch, and the focus is one-twelfth of an inch from the vertex. This determines the whole instrument; for they are all portions of one parabolic conoid. Suppose that the instrument is required to approximate the sound 12 times, as in the example of the conical instrument. The ordinate at the mouth must be 12 times the 6th of an inch, or 2 inches; and the mouth diameter is four inches, as in the conical instrument. Then, for the length, observe, that DC in fig. 7. is $\frac{1}{6}$th of an inch, and MP is 2 inches, and AC is $\frac{1}{12}$th of an inch, and $DC^2 : MP^2 = AC : AP$. This will give $AP = 12$ inches, and $CP = 11\frac{11}{12}$ths; whereas in the conical tube it was 22. In like manner an instrument which approximates the sounds four times, is only $1\frac{1}{3}$d inches long, and $1\frac{1}{3}$d inches diameter at the big end. Such small instruments may be very exactly made in the parabolic form, and are certainly preferable to the conical. But since even these are of a very moderate size when intended to approximate the sound only a few times, and as they can be accurately made by any tinman, they may be of more general use. One of 12 inches long, and 3 inches wide at the big end, should approximate the sound at least 9 times.

Fig. 7.

A general rule for making them.—Let m express the approximating power intended for the instrument. The length of the instrument in inches is $\frac{m \times \overline{m-1}}{6}$, and the diameter at the mouth is $\frac{m}{3}$. The diameter at the small end is always one-third of an inch.

In trumpets for assisting the hearing, all reverbation of the trumpet must be avoided. It must be made thick, of the least elastic materials, and covered with cloth externally. For all reverbation lasts for a short time, and produces new sounds which mix with those that are coming in.

We must also observe, that no acoustic trumpet can separate those sounds to which we listen from others that are made in the same direction. All are received by it, and magnified in the same proportion. This is frequently a very great inconvenience.

There is also another imperfection, which we imagine cannot be removed, namely, an odd confusion, which cannot be called indistinctness, but a feeling as if we were in the midst of an echoing room. The cause seems to be this: Hearing gives us some perception of the direction of the sounding object, not indeed very precise, but sufficiently so for most purposes. In all instruments which we have described for constipating sounds, the last reflections are made in directions very much inclined to the axis, and inclined in many different degrees. Therefore they have the appearance of coming from different quarters; and instead of the perception of a single speaker, we have that of a sounding surface of great extent. We do not know any method of preventing this, and at the same time increasing the sound.

Trumpet.

There is an observation which it is of importance to make on this theory of acoustic instruments. Their performance does not seem to correspond to the computations founded on the theory. When they are tried, we cannot think that they magnify so much: Indeed it is not easy to find a measure by which we can estimate the degrees of audibility. When a man speaks to us at the distance of a yard, and then at the distance of two yards, we can hardly think that there is any difference in the loudness; though theory says, that it is four times less in the last of the two experiments; and we cannot but adhere to the theory in this very simple case, and must attribute the difference to the impossibility of measuring the loudness of sounds with precision. And because we are familiarly acquainted with the sound, we can no more think it four times less at twice the distance, than we can think the visible appearance of a man four times less when he is at quadruple distance. Yet we can completely convince ourselves of this, by observing that he covers the appearance of four men at that distance. We cannot easily make the same experiment with voices.

But, besides this, we have compared two hearing trumpets, one of which should have made a sound as audible at the distance of 40 feet as the other did at 10 feet distance; but we thought them equal at the distance of 40 and 18. The result was the same in many trials made by different persons, and in different circumstances. This leads us to suspect some mistake in Mr Lambert's principle of calculation; and we think him mistaken in the manner of estimating the intensity of the reflected sounds. He conceives the proportion of intensity of the simple voice and of the trumpet to be the same with that of the surface of the mouth-piece to the surface of the sonorous hemisphere, which he has so ingeniously substituted for the trumpet. But this seems to suppose, that the whole surface, generated by the revolution of the quadrantal arch TEG round the axis CG (fig. 4.), is equally sonorous. We are assured that it is not: For even if we should suppose that each of the points Q, R, and S (fig. 3.), are equally sonorous with the point P, these points of reflection do not stand so dense on the surface of the sphere as on the surface of the mouth-piece. Suppose them arranged at equal distances all over the mouth-piece, they will be at equal distances also on the sphere, only in the direction of the arches of great circles which pass through the centre of the mouth-piece. But in the direction perpendicular to this, in the circumference of small circles, having the centre of the mouth-piece for their pole, they must be rarer in the proportion of the sine of their distance from this pole. This is certainly the case with respect to all such sounds as have been reflected in the planes which pass through the axis of the trumpet; and we do not see (for we have not examined this point) that any compensation is made by the reflection which is not in planes.

planes passing through the axis. We therefore imagine, that the trumpet does not increase the sound in the proportion of $g\,E^2$ to $g\,T^2$ (fig. 5.), but in that of $\frac{g\,E^2}{GE}$ to $\frac{g\,T^2}{CT}$.

Mr Lambert seems aware of some error in his calculation, and proposes another, which leads nearly to this conclusion, but founded on a principle which we do not think in the least applicable to the case of sounds.

Trumpet, Marine, is a musical instrument consisting of three tables, which form its triangular body. It has a very long neck with one single string, very thick, mounted on a bridge, which is firm on one side, but tremulous on the other. It is struck by a bow with one hand, and with the other the string is pressed or stopped on the neck by the thumb.

It is the trembling of the bridge, when struck, that makes it imitate the sound of a trumpet, which it does to that perfection, that it is scarcely possible to distinguish the one from the other. And this is what has given it the denomination of trumpet-marine, though, in propriety, it be a kind of monochord. Of the six divisions marked on the neck of the instrument, the first makes a fifth with the open chord, the second an octave, and so on for the rest, corresponding with the intervals of the military trumpet.

Trumpet-Flower. See Bignonia, Botany *Index*.

TRUMPETER. See Psophia, Ornithology *Index*.

TRUNCATED, in general, is an appellation given to such things as have, or seem to have, their points cut off: thus, we say, a truncated cone, pyramid, leaf, &c.

TRUNCHEON, a short staff or baton used by kings, generals, and great officers, as a mark of their command.

TRUNDLE, a sort of carriage with low wheels, whereon heavy and cumbersome burdens are drawn.

TRUNK, among botanists, that part of the herb which arises immediately from the root, and is terminated by fructification; the leaves, buds, and auxiliary parts of the herb not entering in its description.

TRUNNIONS, or Trunions, of a piece of ordnance, are those knobs or bunches of metal which bear her up on the cheeks of the carriage.

TRUSS, a bundle, or certain quantity of hay, straw, &c. A truss of hay contains 56 pounds, or half an hundred weight: 36 trusses make a load.

Truss, is also used for a sort of bandage or ligature made of steel, or the like matter, wherewith to keep up the parts in those who have hernias or ruptures.

Truss, in a ship, a machine employed to pull a yard home to its respective mast, and retain it firmly in that position.

TRUSTEE, one who has an estate, or money, put or trusted in his hands for the use of another.

TRUTH, a term used in opposition to falsehood, and applied to propositions which answer or accord to the nature and reality of the thing whereof something is affirmed or denied.

TRYPHIODORUS, an ancient Greek poet, who lived some time between the reigns of Severus and Anastasius. His writings were very numerous; yet none of them have come down to us, except an epic poem, on which Mr Addison has made some entertaining remarks in the Spectator, N° 63.

The first edition of this extraordinary work was published by Aldus at Venice, with Quintus Calaber's Paralipomena, and Coluthus's poem on the rape of Helen. It has been since reprinted at several places, particularly at Francfort in 1580 by Frischlinus; who not only corrected many corrupt passages, but added two Latin versions, one in verse and the other in prose. That in verse was reprinted in 1742, with the Greek, at Oxford, in 8vo, with an English translation in verse, and Notes, by Mr Merrick.

TUAM, a town of Ireland, in the province of Connaught, and county of Galway, with an archbishop's see. It was once a famous city, though now it is reduced to a village; but it still retains the title of a city, as being an archiepiscopal see. W. Long. 8. 46. N. Lat. 53. 33.

TUB, in commerce, denotes an indetermined quantity or measure: thus, a tub of tea contains about 60 pounds; and a tub of camphor from 56 to 86 pounds.

TUBE, in general, a pipe, conduit, or canal; a cylinder, hollow within-side, either of lead, iron, glass, wood, or other matter, for the air or some other matter to have a free conveyance through it.

Auricular Tube, or instrument to facilitate hearing. See *Articulate Trumpet*.

TUBERCLES, among physicians, denote little tumors which suppurate and discharge pus; and are often found in the lungs, especially of consumptive persons.

TUCUMAN, a province of Paraguay, in South America, bounded on the north by the provinces of Los-Chicas and Choco; on the east by Choco and Rio-de-la-Plata, on the south by the country of Chicuitos and Pampes, and on the west by Chili. The air is hot, and the soil sandy; however, some places are fruitful enough. It now forms part of the republic of Buenos Ayres. See Buenos Ayres, Supplement.

TUFA, a stone consisting of volcanic ashes concreted together with various other species of stone. It is of various colours, blackish gray, bluish gray, and yellow; every colour having a different mixture and solidity: but all of them have the bad quality of mouldering down on long exposure to the weather; notwithstanding which, they have been used in buildings both ancient and modern. The yellow kind resists the air less than any other.

TULIPA, Tulip; a genus of plants belonging to the class of hexandria; and in the natural system ranging under the 10th order, *Coronariæ*. See Botany *Index*; and for the culture of the tulip, see Gardening.

Tulip-Tree. See Liriodendron, Botany *Index*.

TULL, Jethro, an Oxfordshire gentleman who farmed his own land, and introduced a new method of culture, to raise repeated crops of wheat from the same land without the necessity of manure: the principles of which he published about 30 years since, in a Treatise on Horse-hoeing Husbandry.

TUMBRELL, Tumbrellum, or *Turbichetum*, is an engine of punishment, formerly employed for the correction of scolds and unquiet women.

TUMEFACTION, the act of swelling or rising into a tumor.

TUMOR,

TUMOR, in *Medicine* and *Surgery*, a preternatural rising or eminence in any part of the body.

TUMORS, in *Farriery*. See FARRIERY *Index*.

TUN, a large vessel or cask, of an oblong form, biggest in the middle, and diminishing towards its two ends, girt about with hoops, and used for stowing several kinds of merchandise for convenience of carriage; as brandy, oil, sugar, skins, hats, &c.

TUN is also the name of a measure. A tun of wine is four hogsheads; of timber, a square of 40 solid feet; and of coals 20 cwt.

TUN is also a certain weight whereby the burden of ships, &c. is estimated.

TUNBRIDGE, a town of Kent in England, situated on a branch of the river Medway, over which there is a bridge. It is a large well built place, noted for the mineral waters four or five miles south of the town. E. Long. 0. 20. N. Lat. 51. 14.

TUNE. See MUSIC and TONE.

TUNGSTEN, one of the metals. See CHEMISTRY and MINERALOGY *Index*.

TUNICA, a kind of waistcoat or under garment, in use among the Romans. They wore it within doors by itself, and abroad under the gown. The common people could not afford the toga, and so went in their tunics; whence Horace calls them *populus tunicatus*.

TUNICA, in *Anatomy*, is applied to the membranes which invest the vessels, and divers others of the less solid parts of the body; thus the intestines are formed of five tunics or coats.

TUNIS, a large and celebrated town of Barbary, in Africa, and capital of a kingdom of the same name. It is seated on the point of the gulf of Goletta, about eight miles from the place where the city of Carthage stood. It is in the form of a long square, and is about four miles in circumference, with ten large streets, five gates, and 35 mosques. The houses are all built with stone, though but one story high; but the walls are very lofty, and flanked with several strong towers. It has neither ditches nor bastions, but a good citadel, built on an eminence on the west side of the city. Its population is estimated by Mr M'Gill at 100,000, and Mr Blaquiere at 130,000. The divan, or council of state, assembles in an old palace; and the dey is the chief of the republic, who resides there. The harbour of Tunis has a very narrow entrance, through a small canal. In the city they have no water but what is kept in cisterns, except one well kept for the bashaw's use. It is a place of great trade, and is 10 miles from the sea. E. Long. 16. 10. N. Lat. 36. 42.

See Observ. on the City of Tunis by Mr Stanley, in the Edin. Mag. vol. iv. p. 28.

TUNIS, a country of Africa, bounded on the north and east by the Mediterranean sea and the kingdom of Tripoli, on the south by several tribes of the Arabs, and on the west by the kingdom of Algiers and the country of Esab; being 300 miles in length from east to west, and 250 in breadth from north to south. This country was formerly a monarchy; but a difference arising between a king and his son, one of whom was for the protection of the Christians, and the other for that of the Turks, in 1574 the inhabitants shook off the yoke of both. From this time it became a republic under the protection of the Turks, but within the last forty years, it has been almost entirely independent. The air in general is healthy; but the soil in the eastern parts is indifferent for want of water. Towards the middle the mountains and valleys abound in fruits; but the western part is the most fertile, because it is watered with rivers. The environs of Tunis are very dry, upon which account corn is generally dear. The inroads of the Arabs oblige the inhabitants to sow their barley and rye in the suburbs, and to inclose their gardens with walls. However, there are plenty of citrons, lemons, oranges, dates, grapes, and other fruits. There are also olive trees, roses, and odoriferous plants. In the woods and mountains there are lions, wild beeves, ostriches, monkeys, cameleons, roebucks, hares, pheasants, partridges, and other sorts of birds and beasts. The most remarkable rivers are the Guadilcarbar, Magrida, Magerada, and Caps. The form of government is by a council, whose president is the dey. The members of the divan or council are chosen by the dey, and he in his turn is elected by the divan; which is composed of soldiers, who have more than once taken off the dey's head. The bashaw who was formerly a Turk, remitted tribute to Constantinople; but since Hamooda Bey ascended the throne in 1787, Tunis has cast off all subjection to the Porte. The common revenues are only 400,000 crowns a-year, because the people are very poor; nor can they send above 40,000 men into the field; nor more than 12 men of war of the line to sea, even upon the most extraordinary occasions. There are generally about 12,000 Christian slaves in this country; and the inhabitants carry on a great trade in linen and woollen cloth. In the city of Tunis alone there are about 3000 clothiers and weavers. They also have a trade in horses, olives, oil, soap, ostriches eggs and feathers. The Mahometans of this city have nine colleges for students, and 86 petty schools. The principal religion is Mahometanism; but the inhabitants consist of Moors, Turks, Arabs, Jews, and Christian slaves. However the Turks, though fewest in number, domineer over the Moors, and treat them little better than slaves. See BARBARY STATES, SUPPLEMENT.

TUNKERS, a religious sect of Baptists in Pennsylvania, so called from the word *tunker*, to put a morsel in sauce. They are also called *tumblers*, because in performing baptism they plunge the person into the water with the head first. As the Germans sound the letters *t* and *b* like *d* and *p*, the words *tunkers* and *tumblers*, have been sometimes written *dunkers* and *dumplers*. Their church government and discipline are the same with those of the English Baptists, except that every brother is allowed to speak in the congregation, and the best speaker is usually ordained to be their minister. They are a harmless, well-meaning people.

TUNNAGE. See TONNAGE.

TUNNY. See SCOMBER, ICHTHYOLOGY *Index*.

TUNNY-FISHING. See FISHERY.

TURBAN, the head-dress of most of the eastern nations. It consists of two parts, a cap and sash of fine linen or taffety, artfully wound in divers plaits about the cap. The cap has no brim, is pretty flat, though roundish at top, and quilted with cotton; but does not cover the ears. There is a good deal of art in giving the turban a fine air; and the making of them is a particular trade. The sash of the Turk's turban is white linen; that of the Persians red woollen. These are the distinguishing marks of their different religions. Sophi king of Persia, being of the sect of Ali, was the first who assumed the

the red colour, to distinguish himself from the Turks, who are of the sect of Omar, and whom the Persians esteem heretics.

TURBINATED, is a term applied by naturalists to shells which are spiral, or wreathed conically from a larger basis to a kind of apex.

TURBITH or TURPETH MINERAL. See MERCURY, N° 1720 and 1728 CHEMISTRY.

TURBO, the WREATH, a genus of shell-fish. See CONCHOLOGY *Index*.

TURBOT. See PLEURONECTES, ICHTHYOLOGY *Index*.

TURCÆ or TURCI, (Mela); supposed to be the *Tusci* of Ptolemy; whom he places between Caucasus and the Montes Ceraunii. The name is said to denote, "to desolate, or lay waste." Herodotus places them among the wild or barbarous nations of the north. There is a very rapid river called *Turk*, running into the Caspian sea, from which some suppose the Turks to take their name. They made no figure in the world till towards the 7th century; about the beginning of which they sallied forth from the Portæ Caspiæ, laid waste Persia, and joined the Romans against Chosroes king of Persia. In 1402 they subdued the Persians, in whose pay they served, and from whom they derived the Mahometan religion; and afterwards pouring forth, overran Syria, Cappadocia, and the other countries of the Hither Asia, under distinct heads or princes, whom Ottoman subduing, united the whole power in himself, which to this day continues in his family, and who fixed his seat of empire at Prusa in Bithynia. His successors subdued all Greece, and at length took Constantinople in 1453; which put a period to the Roman empire in the East, under Constantine the last emperor. It is a standing tradition or prophecy among the Turks, that their empire will at length be overturned by the Franks or Christians; which seems now to be drawing on apace towards accomplishment.

TURCOISE. See TURQUOISE.

TURCOMANIA, a province of Asiatic Turkey, answering to the ancient kingdom of Armenia.

TURDUS, the THRUSH; a genus of birds belonging to the order of *Passeres*. See ORNITHOLOGY *Index*.

TURENNE, VISCOUNT. See TOUR.

TURF, *peat*, a blackish earth used in several parts of the world as fuel. Turf, as distinguished from peat, consists of mould interwoven with the roots of vegetables.

TURGESCENCE, among physicians, denotes a swelling or growing bloated.

TURGOT, ANNE ROBERT JAMES, a celebrated French financier, was born at Paris in 1727, of a very ancient Norman family. His father was a long time provost of the corporation of merchants; during which he was the object of general admiration, on account of his prudent administration. M. Turgot was the youngest of three brothers, and was destined for the church. He had scarcely attained the age at which reflection commences, when he resolved to sacrifice all temporal advantages to liberty and conscience, and to pursue his ecclesiastical studies without declaring his repugnance to their proposed object. At the age of 23 years he took his degree, and was elected prior of the Sorbonne.

The time when it was necessary for him to declare that he would not be an ecclesiastic was now arrived. He announced this resolution to his father by letter, showing the motives which induced him to decline the clerical order. His father consented, and he was appointed master of requests. M. Turgot prepared himself for this office by particular application to those parts of science which are most connected with its functions and duties, viz. natural philosophy, agriculture, manufactures, commerce, &c. About this period he wrote some articles for the *Encyclopédie*, of which the principal are Etymology, Existence, Expansibility, Fair, and Foundation. He had prepared several others, but the persecution against the *Encyclopédie* induced him to decline farther contributions.

In 1761 M. Turgot was appointed intendant of Limoges, when he gave activity to the society of agriculture; opened a mode of public instruction for female professors of midwifery; procured for the people the attendance of able physicians during the raging of epidemic diseases; established houses of industry, supported by charity (the only species of alms-giving which does not encourage idleness); introduced the cultivation of potatoes into his province, &c. &c. While M. Turgot proceeded with unremitting activity and zeal, in promoting the good of the people over whom he was placed, he meditated projects of a more extensive nature, such as an equal distribution of the taxes, the construction of the roads, the regulation of the militia, the prevention of a scarcity of provision, and the protection of commerce.

At the death of Louis XV. the public voice called M. Turgot to the first offices of government, as a man who united the experience resulting from habits of business to all the improvement which study can procure. After being at the head of the marine department only a short time, he was, Aug. 24, 1774, appointed comptroller general of the finances. During his discharge of this important office, the operations he carried on are astonishing. He suppressed 23 kinds of duties on necessary occupations, useful contracts, or merited compensations. He abolished the corvée, or the labour required from the public for the highways, saving the nation thirty millions of livres annually.—He set aside another kind of corvée, which respected the carriage of military stores and baggage.—He abated the rigour in the administration of indirect impositions, to the great profit of the contributors, the king, and the financiers; beside many other essential improvements in political economy.

At length, however, by the artifices of the courtiers, he was deprived of his offices; and in retirement he devoted himself to the sciences and the belles lettres, which he had cultivated in his youth. Natural philosophy and chemistry were his favourite pursuits; sometimes he indulged in poetry. He composed, it is said, only one Latin verse, intended for a picture of Dr Franklin.

Eripuit cœlo fulmen, mox sceptra tyrannis.

He died in 1781.

TURIN, an ancient and populous city of Italy, and capital of Piedmont, where the sovereign resides, with an archbishop's see, a strong citadel, and an university. It is seated on a vast plain, at the confluence of the rivers Doria and Po. But the air is unhealthy in the autumn

tumn and winter on account of the thick fogs. One half of this place is lately built; and the streets are straight and clean, being washed by an aqueduct. It contains many elegant buildings. When the plague reigned at Marseilles in 1720, a great number of artificers withdrew to Turin; insomuch that there are now above 87,000 inhabitants, and 48 churches and convents. Turin is very well fortified, and extremely strong; as the French found by experience in 1706, who then besieged it a long while to no purpose. The citadel, which is flanked with five bastions, is without doubt a masterpiece of architecture. There are fine walks on the ramparts, and fine gardens on the side of the river Po; and the house commonly called *La Charité* is remarkable, as there is room for 3000 poor people. The college of the academy is very large and well built, and has a great number of ancient inscriptions. In the royal library are 19,000 manuscripts, besides 30,000 printed books. In December 1798, it was taken possession of by the French, who in June following were driven out of it by the Austrians. But with the rest of Italy it is now under the dominion of the French. It is charmingly seated at the foot of a mountain, 62 miles north-east of Genoa, 72 south-west of Milan, and 280 north-west of Rome. E. Long. 7. 45. N. Lat. 44. 50.

1 Situation and extent

TURKEY, an extensive empire, situated partly in Europe, and partly in Asia. It is bounded on the north by the empire of Russia, Hungary, and the Black sea; on the west by the gulf of Venice and the Mediterranean; on the south by the Mediterranean and Arabia; and on the east by Persia. In its present state, we may compute it as extending from the river Unna, in east longitude about 17°, to the mountains which separate it from Persia, in about 50° of east longitude from Greenwich, or about 33° from west to east; while from the most southerly point, a little above Bassora, in north latitude 31°, to the confines of European Russia, in north latitude 47°, it occupies a range of 16° of latitude. In British miles its extent is estimated at 1750 in length, by a medial breadth of about 1000, and its area at 652,960 square miles.

2 Divisions

Turkey is naturally divided into European and Asiatic, separated from each other by the Black sea, the Archipelago, and the straits by which these are connected. European Turkey is subdivided into 11 provinces, viz. MOLDAVIA, BESSARABIA, WALACHIA, BOSNIA, SERVIA (partially), BULGARIA, ROMELIA (including *Macedonia* and *Thrace*), DALMATIA, ALBANIA (including *Epirus*), CROATIA (partially), and the MOREA, or ancient Greece; while Asiatic Turkey is subdivided into seven provinces, viz. NATOLIA (*Asia Minor*), DIARBEC (*Mesopotamia*), SYRIA (including *Judæa*), GEORGIA (*Iberia*), TURCOMANIA (*Armenia*), IRAC-ARABIA, and KURDISTAN (*Assyria*). See each of these articles in the general alphabet.

3 Islands.

The islands belonging to Turkey are extremely numerous; comprising those of the Archipelago, or the Grecian islands, and several in the Levant. The most important are LEMNOS, LESBOS or *Mytilene*, SCIO, SAMOS, COS, RHODES, CYPRUS, CANDIA, PAROS, DELOS, NAXIA, SANCTORINI, PATMOS, NEGROPONT, ANDRO *, COLTERI or *Salamis* *, EGINA, ZANTE *, CEPHALONIA, LEUCADIA, CORFU, and CERIGO or *Cytherea*, which see under their proper heads.

* See Venice.

4 Face of the country.

Both European and Asiatic Turkey abound in mountainous tracts, interspersed with numerous plains and valleys, and here and there a desert of considerable extent. The plains are watered by numerous large rivers, and, in the Asiatic part, consist chiefly of pasture grounds.

5 Mountains.

Among the mountains of European Turkey may be noticed the Carpathian chain, which divides it from the Austrian territories; the celebrated mountains of Hæmus; the Acroceraunian mountains; and the classical hills of Pindus, Ossa, Pelion, and Athos. The most important mountains of Asiatic Turkey are, Mount Caucasus, dividing it from Russia; Mount Taurus, now called Thuron; Olympus; Ida; the mountains of Elivend, and perhaps Mount Ararat, the resting-place of the Ark, dividing it from Persia; and Mount Lebanon, celebrated in scripture for its cedars.

6 Rivers.

The principal river of European Turkey is the Danube, with its tributary streams, the Save, the Morava, the Bosna, and the Pruth; but we may also notice the Marissa or Hebrus, and the Vardan or Axius. In Asiatic Turkey are seen the Kisil-Irmak or Halys, the Saccaria, the Sarabat or Hermus, the Minder or Meander, the Araxes, the Orontes, the Jordan, and the Euphrates.

7 Lakes.

The lakes of European Turkey are of little importance, and in the Asiatic part there are only three that merit notice. These are the Dead sea and the sea of Galilee in Palestine, and the Van in Armenia.

8 Climate and seasons.

The climate in the greater part of the Turkish empire is delightful, and the seasons mild and genial. The heats of the summer, except in the deserts of Syria, and on the shores of the Black sea, are tempered by the keen winds that blow from the higher regions, and the winter is in general extremely mild. The unhealthiness of the large towns on the coast of Asiatic Turkey, is owing much more to the indolent and dirty habits of the people, than to any insalubrity of the climate.

9 Natural history.

Turkey affords a most ample field to the naturalist, whether his taste lead him to explore the animal, the vegetable, or the mineral kingdom. In the first of these he will find the lion, a variety of the tiger, the hyena, the jackall, the ibex, the goat and cat of Angora, and many other quadrupeds common in Europe. Among the birds, one of the most numerous and most useful is the stork; partridges of a large size, quails, woodcocks, cranes, and several birds of prey, are also very common. The Black sea and the Archipelago abound with excellent fish, and contain great variety of curious mollusca, and other marine animals. Among the insects, that destructive animal the locust is a frequent visitant; and Sonnini particularises the tarantula, and a monstrous species of spider, which he calls *galeode arancoide*, or the scorpion spider. Of the domestic animals, the Turks abound in excellent horses, asses of a large size, and that most useful beast of burden, the camel.

To enumerate the vegetable productions of Turkey, would far exceed our scanty limits. The forests of European Turkey, though far less extensive than in ancient times, furnish abundance of the finest timber, especially oak, cedar, larch, walnut, chesnut, and beech, while the olive, the date, the almond, the peech, the mulberry, the cherry, the lemon, and the orange, are the natural productions of Asiatic Turkey. Many of the most valuable drugs employed in medicine, are also the produce of this empire, especially opium, rhubarb, myrrh, asafœtida and other fetid gums, scammony, senna, galls, and coloquintida.

Turkey.

Both gold and silver mines are found in Turkey, but from the indolence of the natives they are scarcely ever worked. Many of the islands abound in mineral treasures, especially Cyprus, where are found mines of gold, copper, vitriol, and iron; and where rock crystal, jasper, and several precious stones, are occasionally procured. The chief mineral production of Turkey, however, is its marble, of which it furnishes several of the most rare and beautiful varieties. That from the Grecian island Paros, is proverbially excellent.

10 Outline of the Turkish history.

The people whom we now call Turks, and who form the great mass of population of the Turkish empire, are generally believed to be the descendants of the ancient Scythians. These are supposed to have migrated from the Altai mountains in Tartary, about the middle of the sixth century, and to have gradually diffused themselves towards the west, till they reached the lake Mæotis, the modern sea of Azof, near which they settled in Armenia Minor or Turcomania. At this time the Roman empire in the east was sufficiently strong to prevent the invaders from extending beyond the river Oxus, on the banks of which they established themselves, and soon became a formidable foe to the emperors of Constantinople.

11 Foundation of the Ottoman empire. A. D. 1300.

There is little certain or interesting in the history of these barbarians till the reign of the caliph Othman, or Osman, who in the end of the 13th century established what from him has been called the Ottoman empire. He first took the title of sultan, and fixed the seat of his government at Prusa, the capital of Bithynia. His successor Orkan was a restless, ambitious, and cruel prince, who greatly extended the limits of the empire, took possession of Gallipoli, and penetrated into Thrace. Amurath the grandson of Osman, in 1362, established the famous military bands called *janizaries*, which still form the chief engines and chief moderators of Turkish despotism. These were first composed of young Christian slaves that had been taken in war, and educated in the Mohammedan religion. They were inured to obedience by severe discipline, and trained to warlike exercise; and as every sentiment which enthusiasm can inspire, and every mark of honour which the favour of the prince could confer, were employed to animate them with martial ardour, and excite in them a sense of their own importance, these janizaries, (or new soldiers) soon became the chief strength and pride of the Ottoman arms. On the assassination of Amurath in 1389, he was succeeded by his son Bajazet, surnamed Ilderim, or the Thunderbolt, whose reign forms one of the most splendid epochs in the Turkish history.

12 Establishment of the Janizaries, 1362.

13 Reign of Bajazet. An. 1389.

Early in this reign, viz. in 1396, the Hungarians were defeated at Nicopoli in Bulgaria, and in 1402, was fought the famous battle between Bajazet and Timur or Tamerlane, the chief of the Moguls, between Cesarea and Ancyra, which ended in the captivity of Bajazet, and the temporary humiliation of the Turks. See MOGULS, N° 19. and 20.

On the death of Bajazet, his son Mousa became sultan, and in 1412 defeated the emperor Sigismund with great slaughter. Mousa was succeeded by his brother Mohammed I. by whom he had been assassinated. The reign of Amurath II. successor of Mohammed, contributed greatly to increase the splendour of the Turkish empire. In this reign Constantinople was attacked, but for the present escaped pillage. Amurath was successfully opposed in his hostilities against the Christian princes, by the Albanian chief George Castriota, whom the Turks call Scanderbeg *.

Amurath was succeeded by Mohammed II. and soon after his accession, viz. in 1453, the city of Constantinople was taken by the Turks, and has ever since remained the capital of their empire. The events of which we have thus drawn the faint outline, are related at some length in the article CONSTANTINOPOLITAN HISTORY, N° 111—168.

14 Taking of Constantinople, An. 1453.

15 Other successes of Mohammed II.

Three years after the taking of Constantinople, Mohammed laid siege to Belgrade, from which, after an obstinate resistance, he was at length repulsed with considerable loss. Abandoning his attempt on Hungary, the sultan made preparations for an expedition into Greece, where the princes Thomas and Demetrius, brothers of the emperor, still continued to maintain their authority. Alarmed at the progress of the Turkish arms, these princes resolved on retiring into Italy, on which the peninsula was seized by the Albanians. This tribe sent a deputation to Mohammed, offering to give up to him the Grecian cities and fortresses, provided they should be allowed to keep the open country; but this offer was rejected by the sultan, who under the appearance of assisting the Greeks, entered the country with a formidable army, defeated the Albanians, took several cities, and carried off great numbers of the inhabitants.

16 Bajazet II. An. 1481.

Mohammed was succeeded by his second son Bajazet II. in 1481, preferred by the janizaries to his elder brother Zizan, who fled for protection to Pope Alexander VI. by whom he is said to have been poisoned, at the instigation of Bajazet, and for the reward of 300,000 ducats. Selim, his youngest son and successor, was a successful prince. He conquered Egypt, Aleppo, Antioch, Tripoli, Damascus, and Gaza, and defeated the Persians. Solyman, surnamed the Magnificent, one of the most accomplished, enterprising, and warlike, of the Turkish princes, ascended the Ottoman throne in consequence of the death of Selim. An. 1512.

17 Solyman I. An. 1520.

Having quelled some insurrections in Asia, he commenced hostilities against the European princes, and entering Hungary, made himself master of Belgrade, then reckoned the chief barrier of that kingdom against the Turkish power. He next turned his victorious arms against the island of Rhodes, then the seat of the knights of St John of Jerusalem. After incredible efforts of courage and military conduct, the knights obtained an honourable capitulation, and retired to the small island of Malta, where they fixed their residence. See MALTA. He afterwards annexed Hungary to the Ottoman empire. His dominions extended from Algiers to the river Euphrates, and from the farther end of the Black sea to the extremity of Greece and Epirus. During the siege of Sigeth, a city of Hungary, before which the Turks lost above 30,000 men, Solyman expired in the 74th year of his age, and 41st of his reign.

18 Selim II. An. 1566.

His son and successor, Selim II. besieged and took Cyprus; but in the famous sea fight at Lepanto, in 1571, the Turkish fleet was utterly destroyed by Don John of Austria. He afterwards invested and took Tunis by storm, putting the garrison to the sword.

19 Amurath III. An. 1575.

On his death, Amurath III. ascended the Ottoman throne, and extended his dominions on both sides by the addition of Raab in Hungary and Tigris in Persia. His son, Mohammed III. has no claim to notice

except

* See Scanderbeg.

Turkey. except on account of his barbarity. He began his reign by strangling 19 of his brothers, and ordering 12 of his
20 father's wives, whom he suspected to be pregnant, to be
Mohammed III. drowned. This monster of cruelty had, however, a successful reign of nine years duration. During the govern-
21 Achmet I. An. 1603. ment of his son, Achmet I. the affairs of Turkey underwent a material change for the worse *. On his death, the janizaries and the divan elected his brother Mustapha, whom in two months they declared incapable of reigning, and threw him into prison; after this they proclaimed his young nephew, Osman, the son of Achmet, emperor. This prince formed a design of curbing the power of the janizaries, for which he was deposed and murdered; and Mustapha was again called from his prison to the imperial throne, but was soon after
22 strangled.

* See *Achmet I.*

Amurath IV. An. 1622. Under Amurath, or Morad IV. surnamed Gasi, the Intrepid, every thing again assumed a new appearance. He was successful in his wars, and took Bagdat from the Persians. A debauch of wine put an end to his life, and dishonoured his memory. His son Ibrahim, who succeeded him, had every vice; he was a weak prince, and wholly destitute of courage. He was strangled by four mutes.

23 Mohammed IV. An. 1649. After a long interval of inactivity, the Turks again became formidable to Europe, under Mohammed IV. who succeeded him. His grand visier Kupuli, who at once directed the councils and conducted the armies of the Porte, took Candia from the Venetians. After carrying on many wars against the Germans, the Poles, the Russians, and other European powers, he was compelled to resign the turban to Solyman II. in 1687, a
An. 1687. prince happy in his domestic government, but unsuccessful in his wars. His brother, Achmet II. was likewise unfortunate in his wars. In his reign the Turks were driven out of Hungary and Transylvania†. The acces-
24 Mustapha II. An. 1695. sion of his nephew, Mustapha II. to the Ottoman throne, gave a new turn to the affairs of the Porte. Possessed of more vigour than his predecessor, he resolved to command his troops in person. He accordingly took the field, passed the Danube, stormed Lippa, seized Itul, and falling suddenly on a body of Imperialists, under Veterani, he killed that officer, dispersed his forces, and closed with success the campaign. He was afterwards defeated by Prince Eugene in an uncommonly bloody battle at Zenta, a small village on the western bank of the Thuyse, in the kingdom of Hungary. About 20,000 Turks were left dead on the field, and 10,000 were drowned in the river, endeavouring to avoid the fury of the sword. The magnificent pavilion of the sultan, and all the stores, fell into the hands of Prince Eugene, and soon after this misfortune the haughty Mustapha was dethroned.

† See *Achmet II.*

25 Achmet III. His brother and successor, Achmet III. gave an asylum to Charles XII. king of Sweden, at Bender, a Turkish town in Moldavia, after his defeat at the battle of Pultava. (See Russia, N° 118. and Sweden, N° 140.). Being unsuccessful in his war against Kouli Khan and the Persians (see Persia), he was deposed,
26 and succeeded by Mohammed V.

Mustapha III. An. 1754. From the deposition of Achmet III. till the accession of Mostapha III. in 1754, nothing of importance occurs in the history of the Turkish empire. During the reign of this latter sultan was begun and terminated that destructive war with Russia, of which the principal events have been enumerated in the article Russia, N° 143 and 144. Turkey.

27 Appearance of a new prophet in Asia. In this reign an extraordinary alarm was excited in Turkey by the sudden appearance of a new prophet in Upper Asia. This man, whose name was *Shiek Mansour*, pretended that he was predoomed by the eternal immutable decrees of heaven to fill up the measure of divine revelation to mankind; and that, as he was to be the last, so he was the greatest of the prophets. The scene of his ministry was in the wide and desolate regions on the borders of the Caspian sea; and though the first rumour of his proceedings represented him as at the head of a multitude of armed enthusiasts, ready to overturn the established government, and the religion of Mohammed, it was soon discovered that all the military fury of his zeal was directed against the Christians. 28

A rebellion in Egypt. About the same time a formidable rebellion broke out in Egypt, which, though it has never properly formed a part of the Turkish empire, may be considered as tributary to the Turks, and as constituting the granary of that empire. This rebellion which has been sufficiently noticed under the article Egypt, N° 125, was suppressed chiefly by the wise conduct and intrepid bravery of Hossan Bey, the captain pacha, who at the age of 70, fought with all the ardour of youth, and all the skill of the most consummate general. That veteran, however, was recalled before he was able to carry all his patriotic designs into execution, that he might aid the divan with his counsel, in the critical situation into which the empire was brought by the arrogant claims of the court of Russia. The result of the deliberations was a precipitate declaration of war against that court, contrary to the better judgment of the old pacha. The war commenced in autumn 1787, and the hordes of Tartars which were first brought into the field, headed by the new prophet, were everywhere defeated by the superior discipline of the Russian troops commanded by Prince Potemkin. Some enterprises which were undertaken by the Turks against the island of Taman and the Krimea were attended with as little success as the attempts of the Tartars; while the emperor Joseph declared to the Porte, that he would assist his ally the empress of Russia with an army of 80,000 men. Four Austrian armies were accordingly assembled; one at Carlstadt in Croatia, under the command of General de Vins; another at Peterwaradin in Hungary, commanded by General Langlois; a third on the borders of Lithuania, under General Febris; and the fourth in the Buccowine, under the orders of the prince of Saxe-Cobourg. Two other generals, 10 lieutenant-generals, and 30 major-generals, were all ordered to prepare for active service in the frontier armies.

The war between the Turks and Austrians was carried on with various success. At first the advantage was evidently on the side of the Ottomans, and the imperial Joseph acquired no warlike renown. His declared purpose was to get possession of Belgrade; from which, however, he was repulsed with disgrace. The prince of Saxe-Cobourg in his department of the war displayed indeed prodigies of valour; but being opposed to a superior force, he was long obliged to act only on the defensive. At length being joined by a body of Russian forces under General Soltikoff, preparations were made for commencing in form the siege of Choczim, which was surrendered to the allied armies on Michael-

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Turkey. mas day 1788, after a defence which would have done honour to the ablest general in Europe. Still, however, success seemed to lean to the Turks. The grand visier made a sudden incursion into the Bannat, and spread consternation and dismay to the very gates of Vienna. The Austrian affairs seemed approaching to a very alarming crisis; not only the splendid views of conquest which were beheld in the imagined partition of a tottering empire had totally disappeared, but had left in their place the sad and gloomy reverse of a discontented and impoverished people, an exhausted treasury, and an army thinned by pestilence and desertion. The first campaign of an invasive war had already produced an impression on the territory of the invader.

In this situation of affairs Marshal Laudohn was with some difficulty drawn from his retirement to take the command of the army in Croatia; and under his auspices fortune began to smile on the Austrian arms. He quickly reduced Dubicza and Nevi, though they were both defended by the most obstinate bravery. He then sat down before Turkish Gradisca; but the autumnal rains coming on with such violence, that the Save overflowed its banks, he was compelled to raise the siege. During this period the war in the Bannat raged with the utmost violence; torrents of blood were shed on both sides; much desperate valour displayed on the one side, and many brave actions performed on the other; while a very great part of that fine but unfortunate country suffered all the desolation and ruin that fire and sword, under the dominion of vengeance and animosity, could inflict. The inhabitants were objects of commiseration; but the injustice with which the emperor had commenced the war, made his personal losses be considered as nothing more than the due reward of his conduct.

29 Accession of Selim III. An. 1789.

In the midst of these military operations Achmet IV. was deposed, and succeeded by Selim III. the late sultan. The new emperor did not want either courage or prudence, and he continued the war with Russia and Austria, with great spirit and resolution. Those events of this war in which the Russians were more immediately concerned, have been already noticed under the article RUSSIA, N° 156, 158, 160 and 161; so that we have merely to relate the remaining operations of the Austrians.

30 Marshal Laudohn takes Gradisca and Belgrade.

Marshal Laudohn renewed his attempts upon Gradisca as soon as the season would permit, and after a brave defence it fell into his hands. This, with some other successes, roused the emperor from his inactivity, and made him seriously determine on the attack which he had long meditated on Belgrade. The enterprise was intrusted to Laudohn, who, with that good fortune which seemed constantly to attend him, made himself master of the place in less than a month. The rest of the campaign was little else than a series of the most important successes. While one detachment of General Laudohn's forces took possession of Czernitz in Walachia, another made itself master of Cladova in Servia. Bucharest, the capital of the former of these provinces, fell without opposition into the hands of Prince Cobourg; while Akerman on the Black sea was reduced by the Russians; and Bender surrendered to Prince Potemkin, not without suspicion of sinister practices, on the 15th of November.

31 Peace with Austria, An. 1790.

Soon after this, the emperor Joseph died, and his successor Leopold shewed a desire for peace. After the reduction of Orsova, therefore, which happened on the 16th of April 1790, the war was carried on with languor on the part of Austria; and in the month of June a conference was agreed on at Reichenbach, at which the ministers of Prussia, Austria, Britain, and the United Provinces, assisted, and at which also an envoy from Poland was occasionally present. After a negociation, which continued till the 17th of August, it was agreed that a peace should be concluded between the king of Hungary and the Ottoman Porte; that the basis of this treaty should be a general surrender of all the conquests made by the former, retaining only Choczim as a security till the Porte should accede to the terms of the agreement, when it also was to be restored.

32 and with Russia.

In the following year the Porte was compelled to conclude a peace with the empress of Russia, and from that period till the deposition of Selim in 1807, no event of consequence has occurred. The Porte has alternately been at war with Britain and with France, but in neither contest has she acquired either honour or territory. As the very confined limits to which we are now reduced forbid us to dwell on these minor transactions, we shall hasten to conclude this historical outline with an account of the revolution which placed Mustapha IV. on the Ottoman empire.

In the spring 1807, the spirit of insurrection had shown itself among the janizaries belonging to the garrisons of the Dardanelles, and in the camp of the grand vizier. In the afternoon of the 25th of May, the garrisons of the castles of the Dardanelles were in a state of tumult, on account of the European uniform, the new tactics, &c. Hali Aga, the commandant of Madschiaburna, on the Asiatic shore, was murdered. Indsche Bey, commandant of the entrance of the Black sea, only escaped the same fate by flight. The reis effendi happening to come to inspect that post just at the same time, the military immediately rose upon him as one of the introducers of the nizam geded. He endeavoured to save himself in a bark, by passing over to Buyukdere, but 100 pistol shots laid him and his attendants dead. It seems that the rage of the janizaries had been embittered against him by the recollection of a promise he made to raise their pay, on condition they would adopt the new discipline, and which promise he never performed. 33 Deposition of Selim and accession of Mustapha IV.

Another circumstance increased the spirit of opposition; the sultan had given notice that the janizaries were no longer to attend him as usual to the mosque, but that this duty was to devolve upon the troops disciplined after the European manner. Thousands of janizaries were now marching to Constantinople, and arrived in the suburb of Pera on the evening of the 28th. They swore to each other to conduct the revolution with the best order. Any person who should in the least injure any Frank was to suffer death. One individual janizary only met with his fate, for taking bread from a Greek (a baker), without paying for it. Behind the janizaries barracks, in the well-known place called Eimeldan, the janizaries planted their colours, and took with them their camp kettles; an infallible signal of insurrection. For a time, the sultan thought of defending himself; and troops, powder, and cannon, were brought to the seraglio. Soon after the mufti, the seimen basche, the kaimakan, and the two kazcakars of Romelia and Natolia, joined the janizaries.

zaries. A council was held in form, and it was proposed as a preliminary, to request the grand seignior to abolish the new discipline by a fettiva from the mufti. The grand seignior, however, thought he should be able to put a stop to the insurrection before the step could be taken, in consequence of his sending the heads of Mahmud, Tersana Emin, Hagi Ibrahim, and the kiaga Mehmesch Effendi, to the Eimeldan. This measure completely failed; the janizaries were more enraged than ever; they did not require the heads of the universally esteemed Mahmud Effendi, but that of the Reis Effendi, then in the camp of the grand vizier.

The janizaries continued to search every place for those ministers, who had promoted the adoption of the European discipline, and publicly avowed themselves as its patrons, namely, Fransisto, Ibrahim, Jussuf Aga, Hadschi Ibrahim, and Achmet Bey, captains of the grand seignior's guard, Hassan Aga, Achmet Effendi, and others, 12 in number, who were all taken, dragged to the Eimeldan, and there cut to pieces. At this juncture the grand seignior sent a hatti scheriff, a letter written in his own hand, in which he for ever abolished the nizam geded, and pronounced an execration on it. But the hatti scheriff was not now accepted; the deposition of the grand seignior was resolved on. The whole force of the janizaries now proceeded to the seraglio. The mufti and the ullemas alone entered the haram, while the rest of the ministers, the agas, the janizaries, and the people, surrounded the palace.

Mustapha IV. born on the 7th of September 1799, the eldest son of the sultan Achmet IV. set aside in 1789, was raised to the Turkish throne, And according to ancient custom, Selim, the former sultan, threw himself at the feet of Mustapha, kissed the border of his garment, and immediately repaired to that department of the seraglio occupied by the princes of the Ottoman blood who no longer reign.

In 1811 the Turks were involved in hostilities again with Russia. After losing several battles, the main body of the Turkish army surrendered prisoners of war to the Russians on the 6th December 1811. The Russians now found scarcely any obstacle to their progress, and continued to advance through the country, along the western shores of the Black Sea; when the invasion of Russia by the French in 1812, saved the Porte from disasters that otherwise seemed inevitable. Peace was obtained with the sacrifice of Bessarabia, and a part of Moldavia, early in 1812.

34 Population of Turkey.

The population of the whole Turkish empire is estimated at 21,000,000. Of these 14,000,000 have been allotted to Asiatic Turkey, and the remaining 7,000,000 to Turkey in Europe. A considerable part of this population consists of Jews and mercantile Christians, from different parts of Europe, who are distinguished by the name of Franks.

35 Government.

The government of Turkey is despotic, but the power of the sultan is by no means so absolute as we are generally led to suppose. Besides, being strictly subject to the laws of the Koran, and thus to the national religion, such obstructions to his absolute will are raised by the power of the mufti, or chief priest and judge, by the frequent insurrections of the janizaries, and the ambition of the pachas, or governors of provinces, that many Christian sovereigns are much more despotic. The principal title of the sultans is, as we have seen, grand seignior, and the court of Constantinople is usually styled the Porte, or Ottoman Porte, either from the large gate at the entrance of the seraglio, or, what is more probable, from the palace of the vizier, where all the affairs of state are transacted. The principal ministers of the Porte are the grand vizier or prime minister, the mufti, the reis effendi or chief secretary of state, the kislar-aga or chief of the black eunuchs, and the aga of the janizaries.

36 Revenues.

The revenue of the whole Turkish empire is not accurately known, but has been estimated at 3,000,000l. sterling. It is partly derived from the capitation tax on unbelievers and from the customs, but principally from the tax on land.

37 Military strength.

The military strength of Turkey is but inconsiderable for so large an empire. The whole of the land forces are supposed never to exceed 150,000 men, and these are ill disciplined, and now dispirited by successive disastrous wars. The navy is estimated at 30 sail of the line; but the ships are ill built, badly manned, and wretchedly navigated.

38 Religion and laws.

The established religion of Turkey is Mahometanism, the tenets of which have been already explained under the articles MAHOMETANISM and ALCORAN. The laws of the empire are entirely founded on the Koran; but in particular cases the judges are guided by certain commentaries on that work, which have acquired the force of laws. The chief of these are the commentaries of Abou-Hanife.

The mufti, or Mohammedan pontiff, resides at Constantinople, but his power has seldom interfered with the civil government. Next to him in rank are the moulahs, who, though esteemed dignitaries of the church, are in fact rather doctors of the law, while the Koran is also a code of civil observance. From the moulahs are selected the inferior muftis or judges throughout the empire, and the cadelesquiers, or chief justices. The next class of divines includes the imaums, or parish priests, who perform the service of the mosques, while the cadis are judges annually appointed to administer justice in the towns and villages, and being regarded as churchmen, like the moulahs, have directed their chief attention to the judicial part of the Koran. From this brief view it will be observed, that the ecclesiastical orders of muftis and imaums somewhat resemble the Christian bishops and parochial clergy; while the other distinctions arise from the singularity of both religion and laws being united in the Koran, so that a lawyer or judge must be at the same time a skilful divine. The Turks have also their monks, styled dervishes, of four various orders and institutions, dedicated by solemn vows to religious offices, public prayer, and preaching. The Greeks, along with their faith, retain their priests, bishops, archbishops, and patriarchs; but their church is in the last state of degradation, and its dignities openly sold by the Turks; this abomination, however, it must be confessed, partly arises from the miserable ambition and avarice of the Greek ecclesiastics, who think they can atone by idle ceremonies for the neglect of all the invaluable morality of the gospel.

39 Language and literature.

The Turkish language is of far inferior reputation to the Persian or Arabic, being a mixture of several dialects, and possessing neither the force, elegance, nor purity

Turkey. rity of these two celebrated oriental tongues. Literature, however, is not wholly neglected, and it has been repeatedly attempted to establish a printing-press at Constantinople; but the design failed from the interest of the copyists, who inferred that this art would deprive them of their bread. A late traveller informs us that there are in this capital several *buttuk-chans*, or public libraries, among which are those of St Sophia, and the Solimanie Jamasy; but none are so elegant as that founded by the grand vizier Raghid, which is wholly built of marble in the midst of a square court, and is filled with books chiefly theological. A librarian constantly attends, and there are convenient seats with carpets and cushions. In the neighbourhood is a school founded by the same vizier, in which about 1000 boys are taught to read and write. The market for books is extensive, containing many shops well supplied with oriental manuscripts. The Turks have their ancient poets, historians, and divines; but of little reputation when compared with those of Persia and Arabia. The state of education among the Turks may be conceived to be very low, and ignorance is indeed a chief part of the national character. The only profession which requires a shadow of learning is that of the law, which is intimately connected with their theology. The celebrated doctors have disciples, who are trained up to that department; but there seems nothing that can deserve the name of college or university.

40 Of commerce.

The Turks cannot be regarded as a commercial people, though they admit of an extensive commercial intercourse with the states of Europe, through the medium of Frank and Greek merchants. The chief ports are Smyrna and Constantinople, the former of which is the great centre of the Levant trade, while the latter is concerned chiefly in the trade with Russia, by the Black sea. At both these ports, and indeed throughout the Turkish empire, the trade is nominally carried on by factors from the different European states; but it is managed more immediately by Jew or Armenian brokers, who take numerous advantages of the ignorance of the factors, and seldom fail to enrich themselves at the expence of their employers. The commodities exported from Turkey, chiefly to Britain, Germany, Italy, Holland, and France, consist for the most part of bees wax, boxwood, silk, cotton yarn, walnut planks, sponges, opium, and other drugs enumerated in N° 9. madder root, and other dye stuffs, and various dried fruits, such as figs, raisins, and currants. The imports are chiefly tin and tin plates, sugar, shalloons, cotton yarn and cotton goods, muslins, clocks and watches, cutlery and glass ware, indigo, gunpowder, pistols and military stores, logwood, rum, coffee, and various spices, especially pepper, ginger, and cinnamon. The exports are principally from Smyrna, where the trade is carried on almost entirely by way of exchange, while at Constantinople the imports are generally paid for by cash or bills. The exchange is commonly against the Turks.

The Turkish money usually employed in commerce is the piastre, which, according to the exchange or agio, is rated at from 13 to 17 in the English pound sterling, so that the average value of the piastre is about 1s. 6d. Each piastre is divided into 40 paras, and each para into three aspers. The principal weight employed is the kintal, equal to about one cwt. English, divided into 44 oke, and each oke into 400 drahen.

41 Character of the Turks.

From their jealousy with respect to strangers, it is extremely difficult to form a true estimate of the national character of the Turks. An intelligent writer, who seems well qualified to direct our judgment in this respect, has thus delineated the Turkish character. "The Turks are in general a sagacious, thinking people; in the pursuit of their own interest, or fortune, their attention is fixed on one object, and they persevere with great steadiness until they attain their purpose. They are in common life seemingly obliging and humane, not without appearances of gratitude: perhaps all or either of these, when extended towards Christians, are practised with a view of some advantage. Interest is their supreme good; where that becomes an object of competition, all attachment of friendship, all ties of consanguinity, are dissolved; they become desperate, no barrier can stop their pursuit, or abate their rancour towards their competitors. In their demeanour they are rather hypochondriac, grave, sedate, and passive; but when agitated by passion, furious, raging, ungovernable; big with dissimulation; jealous, suspicious, and vindictive beyond conception; perpetuating revenge from generation to generation. In matters of religion, tenacious, supercilious, and morose *".

* Potter's Observations on the Religion, Manners, &c. of the Turks, vol. i. p. 4.

42 Manners and customs.

The manners and customs of the Turks are distinguished by the peculiarity of their religion from those of other European nations. On the birth of a child the father himself gives the name, putting at the same time a grain of salt into its mouth. The circumcision is not performed till the age of 12 or 14. Marriage is only a civil contract, which either party may break, and is managed by female mediation, the youth seldom seeing his bride till after the ceremony. The dead are perfumed with incense, and buried in a cloth, open at top and bottom, that the deceased may be able to sit up and answer the questions of the angels of death. The burial-grounds are near the highways, and stones are often placed at the heads of the graves, with carved turbans denoting the sex. As they never intrench upon a former grave, the cemeteries are very extensive. In diet the Turks are extremely moderate, and their meals are dispatched with great haste. Rice is the favourite food, and is dressed in three ways. In boiling, the meat is cut into small pieces, and in roasting still smaller, a bit of meat and an onion being placed alternately on a very long spit. The fish of the Archipelago are excellent, and the beef tolerable, except that of the buffalo, which is very hard. The hares, patridges, and other game, are of superior flavour. The meal is usually spread on a low wooden table, and the master of the house pronounces a short prayer. The frugal repast is followed by fruits and cold water, which are succeeded by hot coffee and pipes with tobacco. The houses of the Turks are seldom expensive; the chief furniture is the carpet which covers the floor, and a low sofa on one side of the room. In regard to dress, Tournefort observes that the use of the turban is unhealthy. The shirt is of callico, and the loose robe is fastened by a girdle, in which is stuck a dagger, while the tobacco box, pocket-book, &c. are worn in the bosom. The robe is generally of European broad cloth, trimmed with various furs. The shoes or slippers are slight, and unfit for much exercise. The dress of the women differs little from that of the men, the chief distinction being the head-dress; that of the fair sex consisting of a bonnet like

like an inverted basket, formed of pasteboard covered with cloth of gold, with a veil extending to the eye-brows, while a fine handkerchief conceals the under part of the face. The personal cleanliness of both sexes is highly laudable; but the European eye is not pleased with the female custom of staining the nails with a red tincture. The amusements of the Turks partake of their indolent apathy, if we except hunting, and those of a military description. To recline on an elegant carpet, or in a hot season by the side of a stream, and smoke the delicate tobacco of Syria, may be regarded as their chief amusement. Chess and draughts are favourite games; but those of chance are considered as incompatible with strict morals. The coffee-houses and baths furnish other sources of amusement; and the bairam, or festival which follows their long lent, is a season of universal dissipation *.

* *Pinkerton's Geography.*

It appears to be a mistaken notion, that the practice of eating opium, to procure intoxication, is general among the Turks. We are assured by a late traveller, that this practice is confined to a few individuals, who are regarded by the majority of their countrymen with as much contempt as drunkards are in the more polished societies of Europe.

TURKEY. See MELEAGRIS, ORNITHOLOGY *Index.*

TURMERIC. See CURCUMA, BOTANY *Index.*

TURNEP, a species of BRASSICA. See BOTANY *Index;* and for the culture, see AGRICULTURE *Index.*

TURNEP-Bread. See BREAD.

TURNEP-FLY. See CHRYSOMELA, ENTOMOLOGY *Index.*

TURNING, the art of forming hard bodies, as wood, ivory, iron, into a round or oval shape, by means of a machine called a *lathe.*

This art was well known to the ancients, and seems to have been carried by them to a very great degree of perfection; at least, if we believe the testimony of Pliny and several other authors, who tell us, that those precious vases enriched with figures in *half relief,* which still adorn our cabinets, were turned on the lathe.

The art of turning is of considerable importance, as it contributes essentially to the perfection of many other arts. The architect uses it for many ornaments, both within and without highly finished houses. The mathematician, the astronomer, and the natural philosopher, have recourse to it, not only to embellish their instruments, but also to give them the necessary dimension and precision. In short, it is an art absolutely necessary to the goldsmith, the watchmaker, the joiner, the smith.

Turning is performed by the lathe, of which there are various kinds, and several instruments, as gouges, chisels, drills, formers, screw tales, used for cutting what is to be turned into its proper form as the lathe turns round. The following is a simple kind of lathe (fig. 1.). in which *a* is the footstool, *b* the cord, *c* the frame of the lathe, *d d* thep uppets, *e e* the points, *f* the spanging-tree.

Plate DXL. fig. 1.

The lathe should be fixed in a place very well lighted; it should be immoveable, and neither too high nor too low. The puppets should neither be so low as to oblige the workman to stoop in order to see his work properly, nor so high that the little chips, which he is continually driving off, should come into his eyes.

The piece to be turned should be rounded (if it be wood) before it be put on the lathe, either with a small hatchet made for the purpose, or with a plane, or with a file, fixing it in a vice, and shaving it down till it is everywhere almost of an equal thickness, and leaving it a little bigger than it is intended to be when finished off. Before putting it on the lathe, it is also necessary to find the centres of its two end surfaces, and that they should be exactly opposite to each other, that when the *points* of the puppets are applied to them, and the piece is turned round, no side may belly out more than another. To find these two centres, lay the piece of wood to be turned upon a plank; open a pair of compasses to almost half the thickness of the piece; fix one of the legs in the plank, and let the point of the other touch one of the ends of the piece, brought into the same plane with the plank on which the compasses is fixed and very near the fixed leg. Describe four arches on that end at equal distances from each other at the circumference of the end, but intersecting one another within; the point of intersection is the centre of the end. In the same manner must the centre in the other end be found. After finding the two centres, make a small hole at each of them, into which insert the points of the puppets, and fix the piece so firmly as not to be shaken out, and yet loose enough to turn round without difficulty.

The piece being thus fixed, it is necessary in the next place to adjust the cord, by making it pass twice round the piece, and in such a manner that the two ends of the cord, both that which is fixed to the *spang* and to the *foot-board,* come off on the side on which the turner stands, that the piece may move against the edge of the cutting-tool and be turned. If the lathe be moved by a wheel, the manner of adjusting the cord needs no directions.

If the workman does not choose to be at the trouble to find the two centres of the piece in the manner described above, let him lay, as nearly as he can, the centre of one end upon the *point* of the left hand *puppet,* and then let him push forward the right hand puppet, striking it with a mallet till its point is as near as he can in the centre of the other end of the piece; and then fixing the right hand puppet by a gentle blow of the mallet on the key, let him turn round the piece to see by the eye if the centres have been properly found. If any part of it bellies out, let him strike that part gently with the mallet till it goes properly; then let him strike one of the puppets pretty smartly to drive the points into the piece, and afterwards fix the puppet by striking the key. If the workman cannot judge by the eye whether the piece be turning properly round its centres or not, he should apply gently the point of an instrument called a *triangular graver,* leaning it on the *rest,* and it will mark by a line the place where the piece is out of its centre; and by striking upon this line with a mallet, the piece can easily be placed properly. The *rest,* of which we have just spoken, ought to be placed upon the two arms of the lathe, and fixed with screws as near the piece as the workman pleases.

The piece being fixed between the two points of the puppets (or, as they are called in Scotland, the *heads*), the cord adjusted, and the *rest* fixed as near the work as possible without touching it; the workman is now to take a *gouge* (fig. 2. in which *a* is the mouth and *b* the handle) of a proper size in his left hand, and hold it by the handle a little inclined, keeping the back of the hand

Fig. 2.

Turning. hand lowermost. With his right hand, the back of which is to be turned upwards, he is to grasp it as near the end as possible on this side of the *rest;* then leaning the gouge on the *rest*, he is to present the edge of it a little higher than the horizontal diameter of the piece, so as to form a kind of tangent to its circumference; then putting the right foot on the foot-board, and turning round the wheel, and holding the gouge firmly on the *rest*, the piece will be cut neatly. In the same manner are the chisels, formers, and other instruments to be used, taking care that the wood be cut equally, and that the instrument be not pushed improperly, sometimes stronger than at others; and taking care also that the instrument used do not follow the work, but that it be kept firmly in the hand without yielding.

The young turner ought to endeavour to acquire the management of the gouge and the chisel, which are the instruments by far the most frequently used, and the most necessary in this art: by them, almost entirely, are the soft woods *turned;* but as for hard woods and other things, as box, ebony, horn, ivory, and the metals, they are hardly ever turned except by *shaving off*. In that case gravers are to be used with square, round, or triangular mouths (fig. 3, 4, 5.). They should be held horizontally while applied to the wood, and not obliquely as directed for the gouge and the chisel.

Fig. 3, 4, and 5.

After the work is completely turned, it is next to be polished; and this cannot be done with the instruments hitherto mentioned. Soft woods, as pear-tree, hazel, maple, ought to be polished with shark-skin or Dutch rushes. There are different species of sharks; some of which have a grayish, others a reddish skin. Shark-skin is always the better to be a good deal used: at first it is too rough for polishing. The *Dutch-rush (equisetum hyemale)*, which grows in moist places among mountains, and is a native of Scotland. The oldest plants are the best. Before using them they should be moistened a little, otherwise they break in pieces almost immediately, and render it exceedingly difficult to polish with them. They are particularly proper for smoothing the hard woods, as box, lignum vitæ, ebony, &c. After having cleaned up the piece well, it should be rubbed gently either with wax or olive-oil, then wiped clean and rubbed with its own raspings or with a cloth a little worn. Ivory, horn, silver, and brass, are polished with pumice-stone finely pounded and put upon leather or a linen cloth a little moistened: with this the piece is rubbed as it turns round in the lathe; and to prevent any dirt from adhering to any part of it, every now and then it is rubbed gently with a small brush dipt in water. To polish very finely, the workmen make use of tripoli, a particular kind of earth, and afterwards of putty or calx of tin. Iron and steel are polished with very fine powder of emery; this is mixed with oil, and put between two pieces of very tender wood, and then the iron is rubbed with it. Tin and silver are polished with a burnisher and that kind of red stone called in France *sanguine dune*. They may be polished also with putty, putting it dry into shamoy-skin, or with the palm of the hand.

To succeed in turning iron, it is necessary to have a *lathe* exceedingly strong in all its parts, and exceedingly well fixed. The puppets should be short, and the *rest* well fixed very near the work: the back of the *rest* should be two or three lines lower than the iron to be turned.

Turning.

The lathe and other instruments being prepared, it is necessary to determine the length and thickness of the iron to be turned according to the design which is to be executed, and to make a model of it in wood a little thicker than it ought to be: Then one exactly like this is to be forged of the best iron that can be procured; that is to say, it must not be new, but well prepared and well beaten with hammers; it must have no flaws, nor cracks, nor pimples. New iron, which has not been well beaten, often contains round drops of cast iron, called by the workmen *grains*, which blunt the edges of the gouges, chisels, and other instruments used for cutting, break them, or make them slide. The iron being forged according to the model, it should be annealed, that is, heated red hot and allowed to cool slowly on the coals till the fire go out of itself. Some people, to soften the iron, cover it over with clay and allow it to cool. The iron cylinder being thus made, it is next to be put upon the lathe, finding the centres as formerly directed, and boring a small hole in them that the iron may not escape from the points.

The points should be oiled from time to time to prevent their being excessively heated and spoiled while the iron is turning. A *crotchet* is then to be applied to the iron to be turned, a little above its centre, pretty gently, and by this means the inequalities of the cylinder will be taken off. Other instruments are then to be applied to mould the iron according to the model; and whenever any of them grow hot, they are to be plunged into a bason of water lying beside the workman. If the iron, after being properly turned, is to be bored like a gun-barrel, one of the puppets is to be removed and another substituted in its place, having a square hole through it, into which the collar of the iron is to be fixed firmly, so as not to shake; then borers are to be applied, like those which locksmiths use to bore keys; and beginning with a small one, and afterwards taking larger ones, the hole is to be made as wide and deep as necessary; great care must be taken to hold the borers firm on the *rest*, otherwise there is danger of not boring the hole straight. The borer must be withdrawn from time to time to oil it and to clean the hole. Since it is difficult to make a hole quite round with borers alone, it is necessary to have also an instrument a good deal smaller than the hole, one of the sides of which is sharp, very well tempered, and a little hollow in the middle. This instrument being fixed in a pretty long handle, is to be applied with steadiness to the inner surface of the hole, and it will entirely remove every inequality that may have been there before its application.

To cut a screw upon the cylinder, some persons use an instrument consisting principally of a female screw; but this is rather an improper instrument; for if one presses too violently, or inclines it ever so little to the right or left, he runs the greatest risk of spoiling the screw. To avoid this danger, some use it only to trace out the lines of the screw, and afterwards finish it with a file. But the following is a much better way. Take a tap for making a female screw, the threads of which have been cut very accurately, and exactly of the size of the screw which you want; and having put it in the opening which you have traced in the collar of the axis

TURNING. PLATE DXL.

Fig. 1.

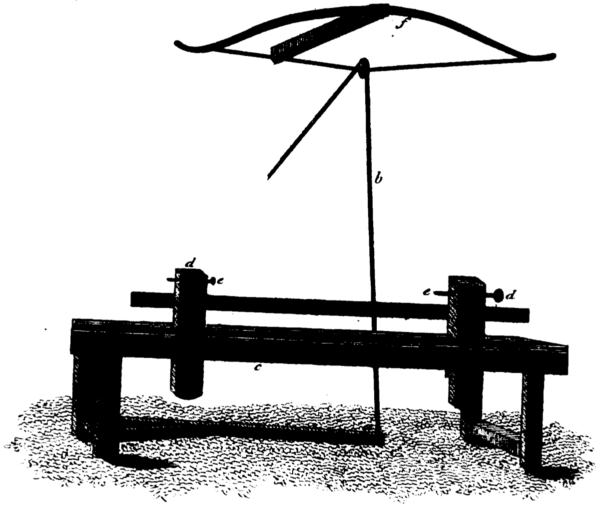
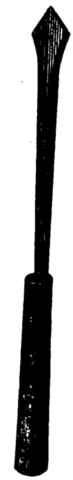


Fig. 2.

Fig. 3

Fig. 4.

Fig. 5.



VARIATION of the Compaſs.

Fig. 1.

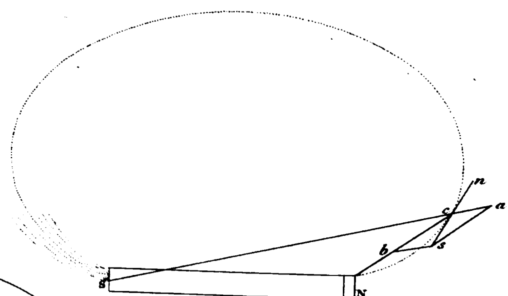


Fig. 3.

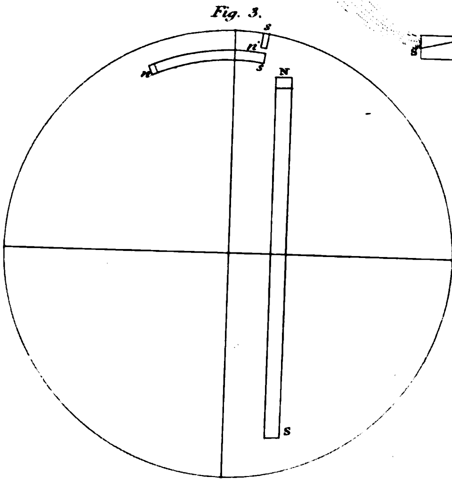
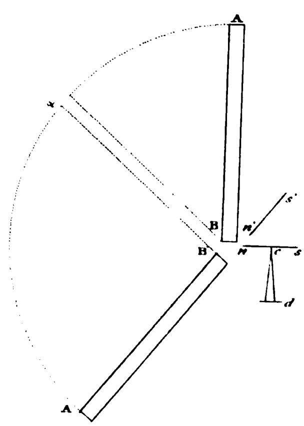


Fig. 2.



Selkirk sculp.t

Turning.

axis on which the screw is to be cut, solder it with tin, sal-ammoniac, and rosin, as exactly corresponding to the axis as possible. Take then a puppet with a hole cut into a corresponding female screw, into which the male screw is to be put. The axis on which the screw is to be cut must be placed exactly horizontally between the two puppets. The *rest* is then to be brought as near as possible to the place where the screw is to be cut, and a small hollow should be cut in that part of it which is exactly opposite to the place where the screw is to be cut, to hold your instrument firmly and prevent it from shaking. The instrument with which the screw is to be cut should be very sharp, and its point should make an angle of 60° with the screw to be cut; and if you wish the screw to be cut very deep, it should make an angle a little larger. The lathe being now put in motion, the tap fixed at the end of the axis will move gradually through the female screw in the puppet; and your instrument in the mean time will trace a similar male screw on the axis fixed in the lathe. Many persons, after having in this manner drawn the outlines of the screw, finish it with a screw-tale of three teeth corresponding exactly to the size of the screw, or with a triangular file; but this last method is rather improper.

For turning ovals, a lathe of somewhat a different construction is used. The axis or spindle, having on it the pulley over which the band-cord passes for turning the lathe, is fixed between the two puppets so as to turn round easily: one end of it passes through one of the puppets, and to it is firmly fixed a circular plate of brass, so that it turns round along with the spindle. Upon this plate two brazen segments of circles are fastened, the circumferences of which correspond to the circumference of the plate: their chords are parallel, and equally distant from the centre of the plate, so that they leave a distance between them. They have a groove in each of them: in these grooves another plate is placed which exactly fills up the space between the two grooves, but is shorter than the diameter of the large circular plate on which it is laid. This plate is made to slide in the grooves. To its centre is fixed a short spindle, on which the piece of wood to be turned is fixed. When the lathe is set a going, the circular plate moves round, and carries the piece along with it; the plate of brass on which the piece is fixed being fixed loosely in the grooves already described, slides down a little every time that the grooves become perpendicular to the floor (and there are particular contrivances to prevent it from sliding down too far); and by these two motions combined, the circular one of the large plate, and the straight one of the small, the circumference of the piece of wood to be turned necessarily describes an oval; and gouges or other tools being applied in the usual manner supported on the *rest*, it is cut into an oval accordingly. The small plate may be made to slide either more or less in the grooves; and by this contrivance the transverse diameter of the oval, or rather ellipse, may be made longer or shorter at pleasure.

1. *The method of moulding boxes of shell and horn.*—In the first place, form a proper mould, which must consist of two pieces, viz. of a circle about half an inch thick, which should slope a little in order to draw out the moulded shell the more easily; and a ring fitted to the outside of the circle, so that both together make the shape of a box. These two pieces being adjusted, it is necessary to round the shell to be moulded of such a size that when moulded, it will be a little higher than the ring of the mould, that there may be no deficiency. The mould is then to be put into a press on a plate of iron, exactly under the screw of the press; put then the shell upon the circle of the mould, so that its centre also is exactly opposite to the screw of the press: then take a piece of wood formed into a truncated cone, and not so thick as the diameter of the circle of the mould, nor so deep as the ring: then put a plate of iron above the cone, and screw down the press gently and cautiously till the whole is well fixed: then plunge the whole into a cauldron of boiling water placed above a fire. In 8 or 10 minutes the shell or horn will begin to soften; screw the press a little firmer that the wooden cone may sink into the softened shell: repeat this from time to time till the cone is quite sunk in the mould; then take out the press and plunge it into cold water. When it is cold, take the box now formed out of the mould, and put into the inside of it a new mould of tin exactly of the form you wish the inside of the box to be; do the same with the outside, put it again into the press and plunge it into boiling water; screw the press gradually till the box receive the desired form.

2. *Method of preparing green wood so that it will not split in the turning.*—Cut the wood into pieces of a proper size, put them into a vessel full of potash ley. Boil them about an hour; take the cauldron from the fire, allow the ley to cool; and take out the wood and dry it in the shade.

3. *Method of giving an ebony-black to hard and fine woods.*—After forming the wood into the destined figure, rub it with aquafortis a little diluted. Small threads of wood will rise in the drying, which you will rub off with pumice-stone. Repeat this process again, and then rub the wood with the following composition: Put into a glazed earthen vessel a pint of strong vinegar, two ounces of fine iron filings, and half a pound of pounded galls, and allow them to infuse for three or four hours on hot cinders. At the end of this time augment the fire, and pour into the vessel four ounces of copperas, and a chopin of water having half an ounce of borax and as much indigo dissolved in it; and make the whole boil till a froth rises. Rub several layers of this upon the wood; and when it is dry, polish it with leather, on which you have put a little tripoli.

4. *Method of giving to plum-tree the colour of brazil wood.*—Slake lime with urine, and bedaub the wood over with it while it is hot: allow it to dry; then take off the coat of lime, and rub it with shamoy skin well oiled. Or, steep the wood in water, having a quantity of alum dissolved in it: then, having allowed brazil wood to dissolve in water five or six hours, steep the wood in it, kept lukewarm during a night; and when it is dry, rub it, as before directed, with shamoy skin well oiled.

5. *Method of giving a fine black colour to wood.*—Steep the wood for two or three days in lukewarm water in which a little alum has been dissolved; then put a handful of logwood, cut small, into a pint of water, and boil it down to less than half a pint. If you then add a little indigo, the colour will be more beautiful. Spread a layer of this liquor quite hot on the wood with a pencil, which will give it a violet colour. When

When it is dry, spread on another layer; dry it again and give it a third: then boil verdegrise at discretion in its own vinegar, and spread a layer of it on the wood: when it is dry, rub it with a brush, and then with oiled shamoy skin. This gives a fine black, and imitates perfectly the colour of ebony.

6. *Method of cleaning and whitening bones before using them.*—Having taken off with a saw the useless ends of the bones, make a strong ley of ashes and quicklime, and into a pailful of this ley put four ounces of alum, and boil the bones in it for an hour; then take the vessel containing the ley off the fire, and let it cool; then take out the bones and dry them in the shade.

7. *Method of soldering shells.*—Clean the two sides of the shells which you wish to join together; then, having joined them, wrap them up in linen folded double and well moistened; then heat two plates of iron pretty hot, that they may keep their heat for some time; and putting the shells rolled up between them under a press, which you must screw very tight, leave them there till the whole is cold, and they will be soldered. If you do not succeed the first time, repeat the process.

8. *Method of moulding shells.*—Put six pints of water into a kettle; add to it an ounce of olive or other oil; make the water boil; then put in your shell, and it will grow soft. Take it out and put it into a mould under a press, and it will take the figure you want. This must be done quickly; for if the shell cool ever so little, the process will fail. It will not require much pressure.

9. *Method of tinging bones and ivory red.*—Boil shavings of scarlet in water. When it begins to boil, throw in a quarter of a pound of ashes made from the dregs of wine, which will extract the colour: then throw in a little rock alum to clear it, and pass the water through a linen cloth. Steep the ivory or bone in aquafortis, and put it into the water. If you wish to leave white spots, cover the places destined for them with wax.

10. *To tinge ivory black.*—Steep the ivory during five or six days in water of galls with ashes made with dried dregs of wine and arsenic; then give it two or three layers of the same black with which plum-tree is blackened, in order to imitate ebony. Or, dissolve silver in aquafortis, and put into it a little rose-water. Rub the ivory with this, and allow it to dry in the sun.

11. *Method of hardening wood to make pulleys.*—After finishing the pulley, boil it seven or eight minutes in olive oil, and it will become as hard as copper.

12. *To make Chinese varnish.*—Take of gum lac in grains four ounces; put it into a strong bottle with a pound of good spirit of wine, and add about the bulk of a hazel nut of camphor. Allow them to mix in summer in the sun, or in winter on hot embers for 24 hours, shaking the bottle from time to time. Pass the whole through a fine cloth, and throw away what remains upon it. Then let it settle for 24 hours, and you will find a clear part in the upper part of the bottle, which you must separate gently, and put into another vial, and the remains will serve for the first layers.

TURNSTONE. See TRINGA, ORNITHOLOGY *Index*.

TURPENTINE, a transparent viscous substance, flowing either naturally or by incision from several resinous trees; as the terebinthus, pine larch, fir, &c. See PINUS, BOTANY *Index*. See also CHEMISTRY and MATERIA MEDICA *Index*.

Oil of TURPENTINE. See CHEMISTRY and MATERIA MEDICA *Index*.

TURPETH, the cortical part of the root of a species of convolvulus. See MATERIA MEDICA *Index*.

TURQUOISE, is the tooth of an animal penetrated with copper ore.

TURRITIS, TOWER-MUSTARD; a genus of plants belonging to the class tetradynamia; and in the natural system ranging under the 39th order, *Siliquosæ*. See BOTANY *Index*.

TURTLE. See TESTUDO, ERPETOLOGY *Index*.

TURTLE Dove. See COLUMBA, ORNITHOLOGY *Index*.

TUSCAN ORDER, in *Architecture*. See ARCHITECTURE, N° 42.

TUSCAN Earth, a yellowish kind of bole found in many parts of Italy, and particularly about Florence, where there is a stratum eight or ten feet thick, at the depth of five or six feet from the surface. It is supposed to have an astringent property.

TUSCANY, a duchy of Italy, which makes part of the ancient Hetruria, and, excepting some detached parts, is encompassed by a part of the Mediterranean, called the *Tuscan sea;* the ecclesiastical state; the duchy of Modena; and the republic of Lucca; its extent from north to south being about 116 English miles, and from east to west about 80; its area 8400; and in 1815 it was estimated to contain 1,195,000 inhabitants.

Though some parts of it are mountainous, yet both the hills and dales are covered with vines, olives, citron, lemon, and orange trees, &c. The mountains yield also copper, iron, alum, &c. and some of the finest marble. Here is also plenty of corn, rice, saffron, honey, wax, wool, flax, hemp, with mineral waters, rich pasture, salt-pits, sulphur, alabaster, calcedony, lapis lazuli, borax, amethysts, carnelians, and jaspers. In some places the elms and ashes yield manna.

The principal river in Tuscany is the Arno, which has its source in the Apennine mountains, and falls into the sea below Pisa. There are some other smaller rivers.

This duchy fell under the dominion of the Romans about 455 years before Christ. The Ostrogoths possessed themselves of it in the fifth century, and after them the Lombards, who were expelled by Charlemagne anno 800; in consequence of which it became subject to the German emperors, who appointed governors over it. At last the cities of Florence, Pisa, Sienna, and some others, during the contentions between the pope and the emperor, and their respective adherents, the Guelphs and Gibbelines, withdrew themselves from the dominion of both, and erected themselves into separate commonwealths. In that of Florence, John de Medicis, a popular nobleman, so insinuated himself into the favour of his countrymen, that they invested him with sovereign power. Pope Pius V. conferred the title of *grand duke* on Cosmo de Medicis anno 1570, in whose family the duchy continued until the death of Gaston de Medicis, who died anno 1737. The duchy was then transferred to the duke of Lorrain, afterwards the emperor.

peror Francis I. in lieu of the duchy of Lorrain, which, by the peace of 1736, was given to King Stanislaus during his life, and then was to be annexed to France. The Austrian family lost this duchy in 1797. After undergoing various changes, it was united to France in 1806, and continued in her possession till the events of 1814 restored its independence. Its prince, who is of the royal family of Spain, is now a minor. The grand duke's annual revenues are computed at about 500,000l. sterling, arising chiefly from the tenths of all estates that are sold or alienated, and the ground rents of the houses in Leghorn, and the duties on almost all manner of provisions.

TUSK, or TORSK. See GADUS, ICHTHYOLOGY *Index*.

TUSSILAGO, COLT'S-FOOT; a genus of plants, belonging to the class of syngenesia; and in the natural system ranging under the 49th order, *Compositæ*. See BOTANY *Index*.

TUTENAG, an alloy of zinc. See CHEMISTRY *Index*.

TUTOR, in the civil law, is one chosen to look to the persons and estates of children left by their fathers and mothers in their minority. The different kinds of *tutory* established among the Romans, and the powers and duties of tutors, are described in *Inst. leg.* 1. tom. xiii. sect. 1. and 2. to which the reader is referred. See also the article GUARDIAN.—For the nature and effects of tutory in the Scotch law, which is founded on that of the Romans. See *Scots LAW*, Part III. Sect. 7.

TUTOR is also used in the English universities for a member of some college or hall, who takes on him the instruction of young students in the arts and faculties.

TUTTY, an impure ore of zinc, employed as an unguent and absorbent. See MATERIA MEDICA *Index*.

TWEED, a river of Scotland, which rises on the confines of Clydesdale, and running eastward through Tweedale, and dividing the shire of Merse from Teviotdale and Northumberland, falls into the German sea at Berwick. It abounds with salmon. See BERWICK.

TWEEDALE, or PEEBLES, a county in the south of Scotland. See PEEBLES-SHIRE.

TWELFTH-DAY, the festival of the Epiphany, or the manifestation of Christ to the Gentiles; so called, as being the twelfth day, exclusive, from the nativity or Christmas-day.

TWILIGHT, that light, whether in the morning before sunrise, or in the evening after sunset, supposed to begin and end when the least stars that can be seen by the naked eye cease or begin to appear.

TWINKLING *of the STARS*. See OPTICS, N° 21.

TWINS, two young ones delivered at a birth, by an animal which ordinarily brings forth but one.

TWITE. See FRINGILLA, ORNITHOLOGY *Index*.

TYGER, or TIGER. See FELIS, MAMMALIA *Index*.

TYLE, or TILE, in building, a thin laminated brick used on the roofs of houses.

TYMPAN, among printers, a double frame belonging to the press, covered with parchment, on which the blank sheets are laid in order to be printed off. See *PRINTING-Press*.

TYMPANUM, in *Mechanics*, a kind of wheel placed round an axis or cylindrical beam, on the top of which are two levers or fixed staves for the more easily turning the axis in order to raise a weight required.

TYMPANUM, in *Anatomy*. See ANATOMY, N° 141.

TYMPANY, or TYMPANITES, in *Medicine*. See MEDICINE, N° 337, and SURGERY *Index*.

TYNDALE, WILLIAM, a zealous English reformer, and memorable for having made the first English version of the Bible, was born on the borders of Wales some time before 1500. He was of Magdalene-hall in Oxford, where he distinguished himself by imbibing early the doctrines of Luther, and by as zealously propagating them. Afterwards he removed to Cambridge, and from thence went to live with a gentleman in Gloucestershire in the capacity of tutor to his children.—While he continued there, he showed himself so furious for Luther, and so inveterate to the pope, that he was forced, merely for the security of his person, to leave the place. He next endeavoured to get into the service of Tonstall bishop of Durham, but did not succeed. His zeal for Lutheranism made him desirous to translate the New Testament into English; and as this could not safely be done in England, he went into Germany, where, setting about the work, he finished it in 1527: He then began with the Old Testament, and finished the five books of Moses, prefixing discourses to each book, as he had done to those of the New Testament. At his first going over into Germany, he went into Saxony, and had much conference with Luther; and then returning to the Netherlands, made his abode chiefly at Antwerp. During his peregrinations from one country to another, he suffered shipwreck upon the coast of Holland, and lost all his books and papers. His translations of the Scriptures being in the mean time sent to England, made a great noise there; and, in the opinion of the clergy, did so much mischief, that a royal proclamation was issued, prohibiting the buying or reading them. But the clergy were not satisfied with this, they knew Tyndale capable of doing infinite harm, and therefore thought of nothing less than removing him out of the way. For this purpose one Philips was sent over to Antwerp, who insinuated himself into his company, and under the pretext of friendship betrayed him into custody. He was sent to the castle of Filford, about 18 miles from Antwerp; and though the English merchants at Antwerp did what they could to procure his release, and letters were also sent from Lord Cromwell and others out of England, yet Philips bestirred himself so heartily, that he was tried and condemned to die. He was first strangled by the hands of the common hangman, and then burned near Filford castle, in 1536. While he was tying to the stake, he cried with a fervent and loud voice, "Lord, open the king of England's eyes."

TYPE (τυπος), an impression, image, or representation of some model, which is termed the *antitype*. In this sense the word occurs often in the writings of divines, who employ it to denote that prefiguration of the great events of man's redemption which they have found or fancied in the principal transactions recorded in the Old Testament.

TYPE, among letter-founders and printers, the same with letter.

TYPE is also used to denote the order observed in the intension and remission of fevers, pulses, &c.

TYPHA, CAT'S-TAIL; a genus of plants belonging to the class of monœcia, and in the natural system ranging under the 3d order, *Calamariæ*. See BOTANY *Index*.

TYPHON. See WHIRLWIND.

TYPHON, the devil of the ancient Egyptians. See POLYTHEISM, N° 29.

TYPOGRAPHY, the art of printing. See PRINTING.

TYRANT, among the ancients, denoted simply a king or monarch; but the ill use which several persons invested with that sacred character made of it, has altered the import of the word; and tyrant now conveys the idea of an unjust or cruel prince, who rules in a more despotic manner than the laws allow.

TYRE, formerly a celebrated city of Asia, on the coast of Syria, situated under the 54th degree of east longitude, and 32d of north latitude. It was built, according to some writers, 2760 years before the Christian era. There were two cities of that name; the one called *Palætyrus*, situated on the continent; and the other the city of *Tyre*, built on an island about half a mile from the shore. It was about 19 miles in circumference, including Palætyrus; the town on the island was about four miles round. The buildings of Tyre were very magnificent; the walls were 150 feet high, and broad in proportion. The city was at one period the most famous commercial city in the world. Of its commercial transactions, the most particular account that is to be found in any ancient writer has been given by the prophet Ezekiel, which at the same time conveys a magnificent idea of the extensive power of that state. It resisted Nebuchadnezzar king of Babylon for 13 years; at the end of which, wearied with fruitless efforts, the inhabitants resolved to place the sea between them and their enemy, and passed accordingly into the island. The new city stood out against Alexander the Great for seven months; and before he could take it, he was obliged to fill up the strait which separated the island from the continent. It was repaired afterwards by Adrian, and became the metropolis of the province. It afterwards fell into the hands of the Arabs; and after being taken by Baldwin II. king of Jerusalem, it was destroyed by the sultan of Egypt in 1289, and abandoned. An excellent account of its modern state may be found in Volney's Travels, vol. ii. It now consists of a small village, composed of fishermen's huts, and containing about 50 or 60 poor families.

TYRIAN DYE. See MUREX, CONCHOLOGY *Index*.

TYRONE, a county of Ireland, in the province of Ulster, 46 miles in length and 37 in breadth; bounded on the north by Londonderry, on the east by Armagh and Lough-Neagh, on the south by Fermanagh, and on the west by Donnegal. It is a rough and rugged country, but tolerably fruitful; contains 12,683 houses, 30 parishes, 4 baronies, 4 boroughs, and formerly sent 10 members to the Irish parliament. The principal town is Dungannon.

U, V.

U, or u, the 20th letter and 5th vowel of our alphabet, is formed in the voice by a round configuration of the lips, and a greater extrusion of the under one than in forming the letter o, and the tongue is also more cannulated. The sound is short in *curst, must, tun, tub;* but is lengthened by a final *e*, as in *tune, tube*, &c. In some words it is rather acute than long; as in *brute, flute, lute*, &c. It is mostly long in polysyllables; as in *union, curious*, &c.; but in some words it is obscure, as in *nature, venture*, &c. This letter in the form of V or v, is properly a consonant, and as such is placed before all the vowels; as in *vacant, venal, vibrate*, &c. Though the letters v and u had always two sounds, they had only the form v till the beginning of the fourth century, when the other form was introduced, the inconvenience of expressing two different sounds by the same letter having been observed long before. In numerals V stands for five; and with a dash added at top, thus $\bar{V}$, it signifies 5000.

In abbreviations, amongst the Romans, V. A. stood for *veterani assignati;* V. B. *viro bono;* V. B. A. *viri boni arbitratu;* V. B. F. *vir bonæ fidei;* V. C. *vir consularis;* V. C. C. F. *vale, conjux charissime, feliciter;* V. D. D. *voto dedicatur;* V. G. *verbi gratia;* Vir. Ve. *virgo vestalis;* VL. *videlicet;* V. N. *quinto nonarum*.

VACCINIUM, the WHORTLE-BERRY, or *Bilberry*, a genus of plants belonging to the class octandria, and arranged in the natural system under the 18th order, *Bicornes*. See BOTANY *Index*.

VACUUM, in *Philosophy*, denotes a space devoid of all matter or body.

It has been greatly disputed whether there be in nature a perfect vacuum, or space void of all matter; but if bodies consist of material solid atoms, it is evident that there must be vacuities, or motion would be impossible (See METAPHYSICS, N° 193.). We can even produce something very near a vacuum in the receiver of an air-pump and in the Torricellian tube (see PNEUMATICS, *passim*).

VADIUM, a pledge in law, is either *vivum* or *mortuum*.

VADIUM *Vivum*, or *Living Pledge*, is when a man borrows a sum (suppose 200l.) of another; and grants him an estate, as of 20l. per annum, to hold till the rents and profits shall repay the sum so borrowed. This is an estate conditioned to be void as soon as such sum is raised. And in this case the land or pledge is said to be living: it subsists, and survives the debts; and, immediately on the discharge of that, reverts to the borrower.

Vadium Mortuum, or *Dead Pledge*. See Mortgage.

VAGABOND, or Vagrant, one who wanders illegally, without a settled habitation. Such persons are cognizable by the laws. See Idleness.

VAGINA, properly signifies a sheath or scabbard; and the term *vagina* is used in architecture for the part of a terminus, because resembling a sheath out of which the statue seems to issue.

Vagina. See Anatomy *Index*.

VAILLANT, John Foy, a physician and great medalist, to whom, according to Voltaire, France was indebted for the science of medals, and Louis XIV. for one half of his cabinet, was born at Beauvais in 1632. Through the means of the minister Colbert he travelled into Italy, Greece, Egypt, and Persia, to collect medals for the royal cabinet; and returned with so many as made the king's cabinet superior to any in Europe. In one of his voyages the ship was taken by an Algerine corsair. After a captivity of near five months he was permitted to return to France, and received at the same time 20 gold medals which had been taken from him. He embarked in a vessel bound for Marseilles, and was carried on with a favourable wind for two days, when another corsair appeared, which, in spite of all the sail they could make, bore down upon them within the reach of cannon shot. Mr Vaillant, dreading the miseries of a fresh slavery, resolved, however, to secure the medals which he had received at Algiers, and therefore swallowed them. But a sudden turn of the wind freed them from this adversary, and cast them upon the coast of Catalonia, where, after expecting to run aground every moment, they at length fell among the sands at the mouth of the Rhone. Mr Vaillant got to shore in a skiff, but felt himself extremely incommoded with the medals he had swallowed, which might weigh altogether five or six ounces, and therefore did not pass like Scarborough waters. He had recourse to a couple of physicians; who were a little puzzled with the singularity of his case; however, nature relieved him from time to time, and he found himself in possession of the greatest part of his treasure when he got to Lyons. Among his collection was an Otho, valuable for its rarity.—He was much caressed on his return; and when Louis XIV. gave a new form to the academy of inscriptions in 1701, Mr Vaillant was first made associate, and then pensionary. He wrote several works relating to ancient coins, and died in 1706.

VAIR, or Vairé, a kind of fur, formerly used for lining the garments of great men and knights of renown. It is represented in engraving by the figures of little bells reversed, ranged in a line. See Heraldry, Chap. II. Sect. 2.

VAIRY, in *Heraldry*, expresses a coat, or the bearings of a coat, when charged or chequered with vairs.

VALAIS, a valley in Swisserland, which extends from the source of the river Rhone to the lake of Geneva. It is near 100 miles in length, but of unequal breadth. It is bounded on the north by the Alps, which separate it from the cantons of Berne and Uri, on the east by the mountains of Forche, on the south by the duchy of Milan and the Val d'Aoste, and on the west by Savoy and the republic of Geneva. The inhabitants profess the Roman Catholic religion, and are subject to the swelling of the throat called *bronchocele*; and idiots are said to abound among them more than in any other place of the globe. They are naturally hardy, enterprising, and good-natured. Valais is surrounded on all sides by very high mountains, most of which are covered with perpetual snow. The soil is fertile in corn, wine, and fruits. The muscat-wine, which is produced here is excellent, and well known all over Europe. This country comprehends 55 large parishes, with one bishop. The religion is the Roman Catholic.

VALANTIA, a genus of plants belonging to the class polygamia, and in the natural system arranged under the 41st order, *Asperifoliæ*. See Botany *Index*.

VALENCIA, a province of Spain, which has the title of a kingdom; and is bounded on the east and south by the Mediterranean sea, on the north by Catalonia and Arragon, and on the west by New Castile and the kingdom of Murcia. It is about 165 miles in length, and 63 in breadth, and in 1788 contained 783,000 inhabitants. It is one of the most agreeable parts of Spain, enjoying almost a perpetual spring. The great number of rivers wherewith it is watered renders it extremely fertile. There are very rugged mountains in it, which contain mines of alum and other minerals.

Valencia, a city of Spain, and capital of the kingdom of the same name. It contains, according to Laborde, 20,000 houses, and 100,000 inhabitants. It has an university, and an archbishop's see; and was taken from the Moors by the Christians in the 13th century. The town is handsome, and adorned with very fine structures. It is not very strong, though there are some bastions along the sides of the walls. They have manufactures in wool and silk, which bring in great sums to the inhabitants. It is seated on the river Guadalaviar, over which there five handsome bridges; and it is about three miles from the sea, where there is a harbour, 110 miles north of Murcia, and 165 east by south of Madrid. This city surrendered to the earl of Peterborough in the year 1705; and suffered dreadfully when taken by Marshal Suchet in 1811. W. Long. 0. 10. N. Lat. 39. 27.

VALENCIENNES, an ancient, strong, and considerable city of France, in the department of the North, containing about 17,000 inhabitants in 1800. The Scheldt divides it into two parts. It is a very important place: the citadel and fortifications, the work of Vauban, were constructed by order of Louis XIV. who took this town from the Spaniards. It was confirmed to him by the treaty of Nimeguen, in 1678. In 1793, it surrendered to the allies after a severe siege; but was afterwards abandoned; and is now in possession of the French. Besides lace, this city is noted for manufactories of woollen stuffs and very fine linens. It is 20 miles west-south-west of Mons, 17 north-east of Cambray, and 120 north-east by north of Paris. E. Long. 3. 37. N. Lat. 50. 21.

VALENS, Flavius, emperor of the East, a great patron of the Arians. Killed by the Goths in the year 379. See Constantinople, N° 76.

VALENTINIAN I. emperor of the West, a renowned warrior, but a tyrant over his subjects. See Rome, N° 523.

Valentinian II. emperor of the West, a prince celebrated for his virtues, and above all for his moderation; yet a conspiracy was formed against him by Arbogastes, Variation. the explanations that have been offered to account for this phenomenon.

About the time that the polarity of the magnet was first observed in Europe, the magnetic direction, both in Europe and in China, was nearly in the plane of the meridian. It was therefore an inestimable present to the mariner, giving him a sure direction in his course through the pathless ocean. But by the time that the European navigators had engaged in their adventurous voyages to far distant shores, the deviation of the needle from the meridian was very sensible even in Europe. The son of Columbus positively says, that it was observed by his father in his first voyage to America, and made his companions so anxious lest they should not find the way back again to their own country, that they mutinied and refused to proceed. It is certain that Gonzales Oviedo and Sebastian Cabot observed it in their voyages. Indeed it could not possibly escape them; for in some parts of their several tracks the needle deviated above 25° from the meridian; and the rudest dead reckoning, made on the supposition of the needle pointing due north and south, must have thrown the navigators into the utmost confusion. We know that spherical trigonometry was at that time abundantly familiar to the mathematicians of Europe, and that no person pretended to take the command of a ship bound to a distant port that was not much more informed in this science than most masters of ships are at present. The deviation of the compass, however, was not generally allowed by mathematicians, who had not yet become sensible of the necessity of quitting the Aristotelian trammels, and investigating nature by experiments. They chose rather to charge the navigators with inaccuracy in their observations than the schoolmen with errors in principles. Pedro de Medina at Valladolid, in his *Arte de Naviggar*, published in 1545, denies the variation of the compass. But the concurring reports of the commanders of ships on distant voyages, in a few years, obliged the landsmen in their closets to give up the point; and Martin Cortez, in a treatise of navigation, printed at Seville before 1556, treats it as a thing completely established, and gives rules and instruments for discovering its quantity. About the year 1580 Norman published his discovery of the *dip* of the needle, and speaks largely of the horizontal deviation from the plane of the meridian, and attributes it to the attraction of a point, not in the heavens, but in the earth, and describes methods by which he hoped to find its place. To the third, and all the subsequent editions of Norman's book (called the *New Attractive*), was subjoined a dissertation by Mr Borroughs, comptroller of the navy, on the variation of the compass, in which is recorded the quantity of this deviation in many places; and he laments the obstacle which it causes to navigation by its total uncertainty previous to observation. The author indeed offers a rule for computing it *à priori*, founded on some conjecture as to its cause; but, with the modesty and candour of a gentleman, acknowledges that this is but a guess, and intreats all navigators to be assiduous in their observations, and ready in communicating them to the public. Accordingly observations were liberally contributed from time to time, and were published in the subsequent treatises on navigation.

But in 1635 the mariners were thrown into a new and great perplexity, by the publication of a *Discourse Mathematical on the Variation of the Magnetical Needle*, by Mr Henry Gillebrand, Gresham professor of astronomy. He had compared the variations observed at London by Burroughs, Gunter, and himself, and found that the north end of the mariner's needle was gradually drawing more to the westward. For Norman and Burroughs had observed it to point about $11\frac{1}{4}$ degrees to the east of north in 1580; Gunter found its deviation only $6\frac{1}{4}$ in 1622, and he himself had observed only 4° in 1634; and it has been found to deviate more and more to the westward ever since, as may be seen from the tables given under MAGNETISM.

Mr Bond, teacher of mathematics in London, and employed to edit and improve the impressions of the popular treatises of navigation, about 1650, declared, in a work called the "Seaman's Kalendar," that he had discovered the true progress of the deviation of the compass; and published in another work, called "the Longitude Found," a table of the variation for 50 years. This was, however, a gratuitous prognostication, not founded on any well-grounded principles; and though it agreed very well with the observations made in London, which showed a gradual motion to the westward at the rate of —.12′ annually, by no means agreed with the observations made in other places. See Phil. Trans. 1668.

But this news soon lost its credit: for the inconsistency with observation appeared more and more every day, and all were anxious to discover some general rule, by which a near guess at least might be made as to the direction of the needle in the most frequented seas. Halley recommended the matter in the most earnest manner to the attention of government; and, after much unwearied solicitation, obtained a ship to be sent on a voyage of discovery for this purpose. He got the command of this ship, in which he repeatedly traversed the Atlantic ocean, and went as far as the 50th degree of southern latitude. See his very curious speculations on this subject in the Phil. Trans. 1683 and 1692.

After he had collected a prodigious number of observations made by others, and compared them with his own, he published in 1700 a synoptical account of them in a very ingenious form of a sea chart, where the ocean was crossed by a number of lines passing through those planes where the compass had the same deviation. Thus, in every point of one line there was no variation in 1700; in every point of another line the compass had 20° of east variation; and in every point of a third line it had 20° of west variation. These lines have since been called *Halleyan lines*, or curves. This chart was received with universal applause, and was undoubtedly one of the most valuable presents that science has made to the arts.

The polarity of the magnetic needle, and a general though intricate connection between its positions in all parts of the world, naturally makes the philosopher speculate about its cause. We see that Cortez ascribed it to the attraction of an eccentric point, and that Bond thought that this point was placed not in the heavens, but in the earth. This notion made the basis of the famous Theory of Magnetism of Dr Gilbert of Colchester. See MAGNETISM, N° 71.

Gilbert's theory may be understood from the following general proposition. Plate DXL. fig 1.

Let NS (fig. 1.) be a magnet, of which N is the north

Variation.

north and S the south pole: Let $n\,s$ be any oblong piece of iron, poised on a point c like a compass needle. It will arrange itself in a position $n\,c\,s$ precisely the same with that which would be assumed by a compass needle of the same size and shape, having n for its north and s its south pole. And while the piece of iron remains in this position, it will be in all respects a magnet similar to the real compass needle. The pole n will attract the south pole of a small magnetised needle, and repel its north pole. If a paper be held over $n\,s$, and fine iron-filings be strewed on it, they will arrange themselves into curves issuing from one of its ends and terminating at the other, in the same manner as they will do when strewed on a paper held over a real compass needle. But this magnetism is quite temporary; for if the piece of iron $n\,s$ be turned the other way, placing n where s now is, it will remain there, and will exhibit the same phenomena. We may here add, that if $n\,s$ be almost infinitely small in comparison of NS, the line $n\,s$ will be in such a position that if $s\,a$, $s\,b$, be drawn parallel to N c, S c, we shall have $s\,a$ to $s\,b$, as the force of the pole N to the force of the pole S. And this is the true cause of that curious disposition of iron-filings when strewed round a magnet. Each fragment becomes a momentary magnet, and arranges itself in the true magnetic direction, and when so arranged, attracts the two adjoining fragments, and co-operates with the forces, which also arrange them. We throw this out to the ingenious mechanician as the foundation of a *complete* theory of the magnetical phenomena. When the filings are infinitely fine, the curves NcS have this property, that, drawing the tangent $n\,c\,s$, we always have $s\,a : s\,b =$ force of N : force of S; and thus we may approximate at pleasure to the law of magnetic attraction and repulsion. The theory, of which an outline is given under MAGNETISM, is founded on this principle, and applies with success to every phenomenon yet observed.

Now, to apply this theory to the point in hand.—Let $n\,s$ (fig. 2.) be a small compass needle, of which n is the north and s the south pole: let this needle be poised horizontally on the pin $c\,d$; and let $n'\,s'$ be the position of the *dipping needle*. Take any long bar of common iron, and hold it upright, or nearly so, as represented by AB. The lower end B will repel the pole n and will attract the pole s, thus exhibiting the properties of a north pole of the bar AB. Keeping B in its place, turn the bar round B′ as a centre, till it come into the position A′ B′ nearly parallel to $n'\,s'$. You will observe the compass needle $n\,s$ attract the end B′ with either pole n or s, when B′ A′ is in the position B′ a perpendicular to the direction $n'\,s'$ of the dipping needle: and when the bar has come into the position B′ A′, the upper end B′ will show itself to be a south pole by attracting n and repelling s. This beautiful experiment was exhibited to the Royal Society in 1673 by Mrs Hindshaw.

From this it appears, that the great magnet in the earth induces a momentary magnetism on soft iron precisely as a common magnet would do. Therefore (says Dr Gilbert) it induces permanent magnetism on magnetisable ores of iron, such as loadstones, in the same manner as a great loadstone would do; and it affects the magnetism already imparted to a piece of tempered steel precisely as any other great magnet would.

Therefore the needle of the mariner's compass in every part of the world arranges itself in the magnetic direction, so that if poised as a dipping needle should be, it will be a tangent to one of the curves NcS of fig. 1. The horizontal needle being so poised as to be capable of playing only in a horizontal plane, will only arrange itself *in the plane* of the triangle NcS. That end of it which has the same magnetism with the south pole S of the great magnet included in the earth will be turned towards its north pole N. Therefore what we call the north pole of a needle or magnet really has the magnetism of the south pole of the great primitive magnet. If the line NS be called the axis, and N and S the poles of this great magnet, the plane of any one of these curves NcS will cut the earth's surface in the circumference of a circle, great or small according as the plane does or does not pass through the centre of the earth.

Dr Halley's first thought was, that the north pole of the great magnet or loadstone which was included in the bowels of the earth was not far from Baffin's bay, and its south pole in the Indian ocean south-west from New Zealand. But he could not find any positions of these two poles which would give the needle that particular position which it was observed to assume in different parts of the world; and he concluded that the great terrestrial loadstone had four irregular poles (a thing not unfrequent in natural loadstones, and easily producible at pleasure), two of which are stronger and two weaker. When the compass is at a great distance from the two north poles, it is affected so as to be directed nearly in a plane passing through the strongest. But if we make it approach much more to the weakest, the greater vicinity will compensate for the smaller absolute force of the weak pole, and occasion considerable irregularities. The appearances are favourable to this opinion. If this be the real constitution of the great magnet, it is almost a desperate task to ascertain by computation what will be the position of the needle. Halley seems to have despaired: for he was both an elegant and a most expert mathematician, and it would have cost *him* little trouble to ascertain the places of two poles only, and the direction which these would have given to the needle. But to say what would be its position when acted on by four poles, it was necessary to know the law by which the magnetic action varied by a variation of distance; and even then, the computation would have been exceedingly difficult.

In order to account for the change of variation, Dr Halley supposes this internal magnet not to adhere to the external shell which we inhabit, but to form a nucleus or kernel detached from it on all sides, and to be so poised as to revolve freely round an axis, the position of which he hopes to discover by observation of the compass. Dr Halley imagined that the nucleus revolved from east to west round the same axis with the earth. Thus the poles of the magnet would change their positions relatively to the earth's surface, and this would change the direction of the compass needle.

The great Euler, whose delight it was always to engage in the most difficult mathematical researches and computations, undertook to ascertain the position of the needle in every part of the earth. His dissertation on this subject is to be seen in the 13th volume of the Memoirs of the Royal Academy of Berlin, and is exceedingly ing beautiful, abounding in those analytical *tours d'adresse* in which he surpassed all the world. He has reduced the computation to a wonderful simplicity.

He found, however, that four poles would engage him in an analysis which would be excessively intricate, and has contented himself with computing for two only; observing that this supposition agrees so well with observation, that it is highly probable that this is the real constitution of the terrestrial magnet, and that the coincidence would have been perfect if he had hit on the due positions of the two poles. He places one of them in lat. 76° north, and long. 96° west from Teneriffe. The south pole is placed in lat. 58° south, and long. 158° west from Teneriffe. These are their situations for 1757.—Mr Euler has annexed to his dissertation a chart of Halleyan curves suited to these assumptions, and fitted to the year 1757.

It must be acknowledged, that the *general* course of the variations according to this theory greatly resembles the real state of things; and we cannot but own ourselves highly indebted to this great mathematician for having made so fine a first attempt. He has improved it very considerably in another dissertation in the 22d volume of these memoirs. But there are still such great differences, that the theory is of no use to the navigator, and it only serves as an excellent model for a farther prosecution of the subject. Since that time another large variation chart has been published, fitted to a late period; but the public has not sufficient information of the authorities or observations on which it is founded.

The great object in all these charts is to facilitate the discovery of a ship's longitude at sea. For the lines of variation being drawn on the chart, and the variation and the latitude being observed at sea, we have only to look on the chart for the intersection of the parallel of observed latitude and the Halleyan curve of observed variation. This intersection must be the place of the ship. This being the purpose, the Halleyan lines are of great service; but they do not give us a ready conception of the direction of the needle. We have always to *imagine* a line drawn through the point, cutting the meridian in the angle corresponding to the Halleyan line. We should learn the general magnetic affections of the globe much better if a number of magnetic meridians were drawn. These are the intersections of the earth's surface with planes passing through the magnetical axis, cutting one another in angles of 5° or 10°. This would both show us the places of the magnetic poles much more clearly, and would, in every place, show us at once the direction of the needle. In all those places where these magnetic curves touch the meridians, there is no variation; and the variation in every other place is the angle contained between these magnetic meridians and the true ones.

The program of a work of this kind has been published by a Mr Churchman, who appears to have engaged in the investigation with great zeal and considerable opportunities. It is pretty certain that the north magnetic pole (or point, as Mr Churchman calls it) is not far removed from the stations given it by Halley and Euler; and there seems no doubt but that in the countries between Hudson's bay and the western coasts of North America the needle will have every position with respect to the terrestrial meridian, so that the north end of a compass needle will even point due south in several places. Almost every thing that can be desired in this inquiry would be obtained by a few *well-chosen* observations made in those regions. It would be of immense advantage to have the *dips* ascertained with great precision. These would enable us to judge at what depth under the surface the pole is situated; for the well-informed mechanician, who will study seriously what we have said about the magnetical curves, will see that a compass needle, when compared with the great terrestrial magnet, is but as a particle of iron-filings compared to a very large artificial magnet. Therefore, from the position of the dipping needle, we may infer the place of the pole, if the law of magnetic action be given; and this law may be found by means of other experiments, which we could point out. See MAGNETISM, N° 80, *et seq.*

Mr Churchman has adopted the opinion of only two poles. According to him, the north pole was (in 1800) in Lat. 58° N. and Long. 134° W. from Greenwich, very near Cape Fairweather; and the south pole lies in Lat. 58° S. and Long. 165° E. from Greenwich. He also imagines that the north pole has moved to the eastward, on a parallel of latitude, about 65 since the beginning of the 19th century (from 1600), and concludes that it makes a revolution in 1096 years. The southern pole has moved less, and completes its revolution in 2289 years. This motion he ascribes to some influences which he calls *magnetic tides*, and which he seems to consider as celestial. This he infers from the changes of variation. He announces a physical theory on this subject, which, he says, enables him to compute the variation with precision for any time past or to come; and he even gives the process of trigonometrical computation illustrated by examples. But as this publication (entitled *The Magnetic Atlas*), published for the author, by Darton and Harvey, 1794, is only a program, he expresses himself obscurely, and somewhat enigmatically, respecting his theory. He speaks of the influence of one pole being greater than that of the other; and says, that in this case the magnetic equator, where the needle will be parallel to the axis, will not be in the middle between the poles. This is true of a common magnet. He must therefore abide by this supposition in its other consequences. The magnetic meridians must be planes passing through this axis, and therefore must be circles on the surface of the earth. This is incompatible with the observations; nay, his charts are so in many places, particularly in the Pacific ocean, where the variations by his chart are three times greater than what has been observed.—His parallels of dip are still more different from observation, and are incompatible with any phenomena that could be produced by a magnet having but two poles. His rules of computation are exceedingly exceptionable. He has in fact but one example, and that so particular, that the mode of computation will not apply to any other. This circumstance is not taken notice of in the enunciation of his first problem; and the reader is made to imagine that he has got a rule for computing the variation, whereas all the rules of calculation are only running in a circle. The variation computed for the port of St Peter and Paul in Kamtschatka, by the rule, is ten times greater than the truth.

For our own part, we have little hopes of this problem ever being subjected to accurate calculation. We believe, Variation.

believe, indeed, that there is a cosmical change going on in the earth which will produce a progressive change in the variation of the needle; and we see none more likely than Dr Halley's motion. There is nothing repugnant to our knowledge of the universe in the supposition of a magnetic nucleus revolving within this earth; and it is very easy to conceive a very simple motion of revolution, which shall produce the very motion of the sensible poles for which Mr Churchman contends. We need only suppose that the magnetical axis of this nucleus is not its axis of revolution. It may not even bisect that axis; and this circumstance will cause the two poles to have different degrees of motion in relation to the shell which surrounds it.

But this regular progress of the magnet within the earth may produce very irregular motions of the compass needle, by the intervention of a third body susceptible of magnetism. The theory of which we have just given a hint comes here to our assistance. Suppose NS (fig. 3.) to represent the primitive magnet in the earth, and *n s* to be a stratum of iron ore susceptible of magnetism. Also let *n' s'* be another small mass of a similar ore; and let their situations and magnitudes be such as is exhibited in the figure. The fact will be that *n* will be the north pole and *s* the south pole of the great stratum, and *n'* and *s'* will be the north and south poles of the small mass or loadstone. Any person may remove all doubts as to this, by making the experiment with a magnet NS, a piece of iron or soft tempered steel *n s*, and another piece *n' s'*. The well-informed and attentive reader will easily see, that by such interventions every conceivable anomaly may be produced. While the great magnet makes a revolution in any direction, the needle will change its position gradually, and with a certain regularity; but it will depend entirely on the size, shape, and situation, of these intervening masses of magnetisable iron ore, whether the change of variation of the compass shall be such as the primitive magnet alone would have produced, or whether it shall be of a kind wholly different.

Now, that such intervening disturbances *may* exist, is past contradiction. We know that even on the film of earth which we inhabit, and with which only we are acquainted, there are extensive strata or otherwise disposed masses of iron ores in a state susceptible of magnetism; and experiments made on bars of hard tempered steel, and on bits of such ores, assure us that the magnetism is not induced on such bodies in a moment, but propagated gradually along the mass.—That such disturbances do actually exist, we have many relations. There are many instances on record of very extensive magnetic rocks, which affect the needle to very considerable distances. The island of Elba in the Mediterranean is a very remarkable instance of this. The island of Cannay also, on the west of Scotland, has rocks which affect the needle at a great distance.

A similar effect is observed near the Feroe islands in the North sea; the compass has no determined direction when brought on shore. *Journ. des Sçavans*, 1679, p. 174.

In Hudson's straits, in latitude 63°, the needle has hardly any polarity. *Ellis's Voyage to Hudson's Bay.*

Bouguer observed the same thing in Peru. Nay, we believe that almost all rocks, especially of whin or trappe stone, contain iron in a proper state.

All this refers only to the thin crust through which the human eye has occasionally penetrated. Of what may be below we are ignorant; but when we see appearances which tally so remarkably with what would be the effects of great masses of magnetical bodies, modifying the general and regularly progressive action of a primitive magnet, whose existence and motion is inconsistent with nothing that we know of this globe, this manner of accounting for the observed change of variation has all the probability that we can desire. Nay, we apprehend that very considerable changes may be produced in the direction of the compass needle, even without the supposition of any internal motion. If the great magnet resembles many loadstones we are acquainted with, having more than two poles, we know that these poles will act on each other, and gradually change each other's force, and consequently the direction of the compass. This process, to be sure, tends to a state of things which will change no more.—But the period of human history, or of the history of the race of Adam, may make but a small part of the history of this globe; and therefore this objection is of little force.

There can be no doubt of the operation of the general terrestrial magnetism on every thing susceptible of magnetic properties; and we cannot hesitate to explain in this way many changes of magnetic direction which have been observed. Thus, in Italy, Father de la Torré observed, that during a great eruption of Vesuvius the variation was 16° in the morning, at noon it was 14°, and in the evening it was 10°, and that it continued in that state till the lava grew so dark as no longer to be visible in the night; after which it slowly increased to 13½, where it remained. Daniel Bernoulli found the needle changed its position 45′ by an earthquake. Professor Muller at Manheim observed that the declination of the needle in that place was greatly affected by the earthquake in Calabria. Such streams of lava as flowed from Hecla in the last dreadful eruption must have made a transference of magnetic matter that would considerably affect the needle. But no observations seem to have been made on the occasion; for we know that common ironstone, which has no effect on the needle, will, by mere cementation with any inflammable substance, become magnetic. In this way Dr Knight sometimes made artificial loadstones.—But these are partial things, and not connected with the general change of variation now under consideration.

We have said so much on this subject, chiefly with the view of cautioning our readers against too sanguine expectations from any pretensions to the solution of this great problem. We may certainly gather from these observations, that even although the theory of the variation should be completed, we must expect (by what we already know of magnetism in general) that the disturbances of the needle, by local causes intervening between it and the great influence by which it is chiefly directed, may be so considerable as to affect the position of the compass needle in a very sensible manner: for we know that the metallic substances in the bowels of the earth are in a state of continual change, and this to an extent altogether unknown.

There is another irregularity of the mariner's needle that we have noticed under MAGNETISM, page 365, namely, the daily variation. This was first observed by by Mr George Graham in 1722 (Philosophical Transactions, N° 383.), and reported to the Royal Society of London. It usually moves (at least in Europe) to the westward from 8 morning till 2 P. M. and then gradually returns to its former situation. The diurnal variations are seldom less than 0° 5′, and often much greater. Mr Graham mentions (Philosophical Transactions, N° 428.) some observations by a Captain Hume, in a voyage to America, where he found the variation greatest in the afternoon. This being a general phenomenon, has also attracted the attention of philosophers. The most detailed accounts of it to be met with are those of Mr Canton (see MAGNETISM), in Philosophical Transactions, vol. li. part 1. p. 399, and those of Van Swinden, in his Treatise on Electricity and Magnetism.

Mr Canton attempts to account for these changes of position, by observing that the force of a magnet is weakened by heat. A small magnet being placed near a compass needle, ENE from it, so as to make it deflect 45° from the natural position, the magnet was covered with a brass vessel, into which hot water was poured. The needle gradually receded from the magnet 45′, and returned gradually to its place as the water cooled. This is confirmed by uniform experience.

The parts of the earth to the eastward are first heated in the morning, and therefore the force of the earth is weakened, and the needle is made to move to the westward. But as the sun warms the western side of the earth in the afternoon, the motion of the needle must take the contrary direction. This explanation, however, does not account for the prodigious diversity in the diurnal variation at different places, and is besides exposed to other very weighty objections.

But, besides this regular diurnal variation, there is another, which is subjected to no rule. The aurora borealis is observed (in Europe) to disturb the needle exceedingly, sometimes drawing it several degrees from its position. It is always observed to increase its deviation from the meridian, that is, an aurora borealis makes the needle point more westerly. This disturbance sometimes amounts to six or seven degrees, and is generally observed to be greatest when the aurora borealis is most remarkable.

The observation of the connection of the polarity of the needle with the aurora borealis occurred to the late Professor Robinson in 1759, when a midshipman on board the Royal William in the river St Lawrence. The point of the heavens to which all the rays of light converged was precisely that which was opposite to the south end of the dipping needle.

This is a very curious phenomenon, and we have not been able to find any connection between this meteor and the position of a magnetic needle. It is to be observed, that a needle of copper or wood, or any substance except iron, is not affected. We long thought it an electric phenomenon, and that the needle was affected as any other body balanced in the same manner would be; but a copper needle would then be affected.

We see the needle frequently disturbed both from its general annual position, and from the change made on it by the diurnal variation. This is probably the effect of auroræ boreales which are invisible, either on account of thick weather or daylight. Van Swinden says, he seldom or never failed to observe auroræ boreales immediately after any anomalous motion of the needle; and concluded that there had been one at the time, though he could not see it. Since no needle but a magnetic one is affected by the aurora borealis, we may conclude that there is some natural connection between this meteor and magnetism. This should farther incite us to observe the circumstance above mentioned, viz. that the south end of the dipping needle points to that part of the heavens where the rays of the aurora appear to converge. We wish that this were diligently observed in places which have very different variation and dip of the mariner's needle.

Another species of variation of great importance has lately been discovered. This arises from the action of the mass of the ship on the needle, and is found in some cases to amount to five degrees, so that when bearings are taken with the ship's head first on one side of the magnetic meridian, and then on the other, a difference will be found of ten degrees. Anomalies arising from this source had been often observed, and had greatly perplexed nautical men: they were often attributed to the defects of the compass. Captain Flinders seems to have been the first who detected the true cause of these irregularities, by ascertaining that the mean variation taken with five different compasses at the binnacle, was 4° 37′ greater than at the booms. This subject, however, was first fully investigated and explained by Mr William Bain, a nautical gentleman, in a small tract published at Edinburgh in 1817. Mr Bain having detected the effects of the local attraction of the ship by his own observations in 1811, has, by means of this principle, satisfactorily explained many facts recorded by former navigators, which appeared hitherto inexplicable. He shows, that in the short course from Plymouth to Cape Finisterre, by neglecting this local attraction, an error of 12 miles may be committed in latitude, and of 35 in longitude. In the course from St John's Newfoundland to England, the error from the same cause may amount to 64 miles in latitude, and 198 in longitude. He observes also, that in beating to windward, and tacking pretty often, all seamen have remarked, that every time the ship was put about, the wind *came round* some points with the ship. This change in the wind, however, is merely apparent, and is simply the effect of the attraction of the ship upon the needle. When the head is westerly, the north end of the needle is drawn half the difference westward; when the head is easterly, it is drawn half the difference eastward. He has also shewn, that many of the irregularities ascribed to currents are truly owing to this cause. The amount of the local variation caused by the ship must depend on her construction, and in a merchant vessel on her cargo. It will therefore most probably vary in different ships, and in the same ship, at different times. Mr Bain thinks that it would be advisable for every merchant vessel before she leaves the port, to ascertain by observations made on some fixed object at a distance, the precise amount of this local attraction; and when this is once known, she may steer her course with much greater confidence and security. For farther particulars the reader may consult Mr Bain's excellent little work, entitled, "An Essay on the Variation of the Compass."

Compass." Edinburgh, 1817. The discovery of this species of variation well deserves to be regarded as an important step in the improvement of navigation.

For the diurnal and this irregular variaion, consult the Dissertations of Celsius and of Hiorter, in the Memoirs of Stockholm; Wargentin, Philosophical Transactions, vol. xlviii.; Braun (*Comment. Petropol. Novi*, tom. v. vii. ix.); Graham and Canton as above.

VARIETY, a change, succession or difference, in the appearance or nature of things; in opposition to *uniformity*.

VARIETY, in *Botany*, is a change in some less essential part or quality; as colour, size, pubescence or age. —Externally; by the plaiting or interweaving of the branches—by bundling or uniting of several stalks into one broad flat one; by the greater breadth or narrowness, or curling of leaves—by becoming awnless, or smooth, or hirsute. Internally; by becoming mutilated in the corolla; or having one larger than ordinary —by luxuriancy, multiplication, or fulness—by becoming proliferous, or crested—by bearing bulbs instead of seeds—or being viviparous.

The usual causes of variation are, climate, soil, exposure, heat, cold, winds, culture.

VARIOLA, the SMALLPOX. See MEDICINE, N° 222—224.

VARIX, in *Medicine*, the dilatation of a vein, arising from the too great abundance or thickness of the blood.

VARNISH, a clear limpid fluid, capable of hardening without losing its transparency, used by painters, gilders, &c. to give a lustre to their works, to preserve them and defend them from the air.

A coat of varnish ought to possess the following properties: 1. It must exclude the action of the air; because wood and metals are varnished to defend them from decay and rust. 2. It must resist water; for otherwise the effect of the varnish could not be permanent. 3. It ought not to alter such colours as are intended to be preserved by this means. It is necessary therefore that a varnish should be easily extended or spread over the surface, without leaving pores or cavities; that it should not crack or scale; and that it should resist water. Now resins are the only bodies that possess these properties. Resins consequently must be used as the bases of varnish. The question which of course presents itself must then be, how to dispose them for this use? and for this purpose they must be dissolved, as minutely divided as possible, and combined in such a manner that the imperfections of those which might be disposed to scale may be corrected by others.

Resins may be dissolved by three agents. 1. By fixed oil. 2. By volatile oil. 3. By alcohol. And accordingly we have three kinds of varnish; the fat or oily varnish, essential varnish, and spirit varnish. Before a resin is dissolved in a fixed oil, it is necessary to render the oil drying. For this purpose the oil is boiled with metallic oxides; in which operation the mucilage of the oil combines with the metal, while the oil itself unites with the oxygen of the oxide. To accelerate the drying of this varnish, it is necessary to add oil of turpentine. The essential varnishes consist of a solution of resin in oil of turpentine. The varnish being applied, the essential oil flies off, and leaves the resin. This is used only for paintings. When resins are dissolved in alcohol, the varnish dries very speedily, and is subject to crack; but this fault is corrected by adding a small quantity of turpentine to the mixture, which renders it brighter, and less brittle when dry.

We shall now give the method of preparing a number of varnishes for different purposes.

A Varnish for Toilet-boxes, Cases, Fans, &c.—Dissolve two ounces of gum mastich and eight ounces of gum sandarach in a quart of alcohol; then add four ounces of Venice turpentine.

A Varnish for Wainscots, Cane-chairs, Iron-chairs, Grates.—Dissolve in a quart of alcohol eight ounces of gum sandarach, two ounces of seed lac, four ounces of rosin; then add six ounces of Venice turpentine. If the varnish is wished to produce a red colour, more of the lac and less of sandarach should be used, and a little *dragon's blood* should be added. This varnish is so thick that two layers of it are equal to four or five of another.

A Varnish for Fiddles, and other Musical Instruments. —Put four ounces of gum sandarach, two ounces of lac, two ounces of gum mastich, an ounce of gum elemi, into a quart of alcohol, and hang them over a slow fire till they are dissolved; then add two ounces of turpentine.

Varnish in order to employ Vermilion for painting Equipages.—Dissolve in a quart of alcohol six ounces of sandarach, three ounces of gum lac, and four ounces of rosin; afterwards add six ounces of the cheapest kind of turpentine; mix with it a proper quantity of vermilion when it is to be used.

Gold-coloured Varnish.—Pound separately four ounces of stick lac, four ounces of gamboge, four ounces of dragon's blood, four ounces of anotta, and one ounce of saffron: put each of them separately into a quart of alcohol, and expose them for five days in a narrow-mouthed bottle to the sun, or keep them during that time in a very warm room, shaking them every now and then to hasten the solution. When they are all melted, mix them together. More or less of each of these ingredients will give the different tints of gold according as they are combined. In order to make silver imitate gold exactly when covered with this varnish, the quantity of ingredients must be somewhat greater. The method of gilding silver-leaf, &c. with this varnish is as follows: The silver-leaf being fixed on the subject, in the same manner as gold-leaf, by the interposition of proper glutinous matters, the varnish is spread upon the piece with a brush or pencil. The first coat being dry, the piece is again and again washed over with the varnish till the colour appears sufficiently deep. What is called *gilt leather*, and many picture frames, have no other than this counterfeit gilding. Washing them with a little rectified spirit of wine affords a proof of this; the spirit dissolving the varnish, and leaving the silver-leaf of its own whiteness. For plain frames, thick tinfoil may be used instead of silver. The tin-leaf, fixed on the piece with glue, is to be burnished, then polished with emery and a fine linen cloth, and afterwards with putty applied in the same manner: being then lacquered over with the varnish five or six times, it looks very nearly like burnished gold. The same varnish, made with a less proportion of the colouring materials, is applied also on works of brass; both for heightening the colour of the metal to a resemblance with that of gold, and

Varnish. and for preserving it from being tarnished or corroded by the air.

Oil Varnishes.—Gum copal and amber are the substances principally employed in oil varnishes; they possess the properties necessary for varnishes, solidity and transparency.—The copal being whitest, is used for varnishing light, the amber for dark colours. It is best to dissolve them before mixing them with the oil, because by this means they are in less danger of being scorched, and at the same time the varnish is more beautiful. They should be melted in a pot on the fire; they are in a proper state for receiving the oil when they give no resistance to the iron spatula, and when they run off from it drop by drop. The oil employed should be a drying oil, and perfectly free from grease. It should be poured into the copal or amber by little and little, constantly stirring the ingredients at the same time with the spatula. When the oil is well mixed with the copal or amber, take it off the fire; and when it is pretty cool, pour in a greater quantity of the essence of turpentine than the oil that was used. After the varnish is made, it should be passed through a linen cloth. Oil varnishes become thick by keeping; but when they are to be used, it is only necessary to pour in a little essence of turpentine, and to put them for a little on the fire. The turpentine is necessary in oil varnishes to make them dry properly; generally twice as much of it is used as of oil. Less is necessary in summer than in winter. Too much oil binders the varnish from drying; but when too little is used, it cracks and does not spread properly. We shall subjoin the most useful oil varnishes:

White Copal Varnish.—On 16 ounces of melted copal pour four, six, or eight ounces of linseed oil, boiled and quite free from grease. When they are well mixed, take them off the fire (not forgetting to stir them properly); and when pretty cool, pour in 16 ounces of the essence of Venice turpentine. Pass the varnish through a cloth.—Amber varnish is made in the same way.

Black Varnish for Coaches and Iron Work.—This varnish is composed of bitumen of Palestine, rosin, and amber, melted separately, and afterwards mixed: the oil is then added, and afterwards the turpentine, as directed above. The usual proportions are, 12 ounces of amber, two ounces of rosin, two ounces of bitumen, six of oil, and 12 of the essence of turpentine.—Golden-coloured varnish may be made also by substituting linseed oil for alcohol.

Essential Oil Varnishes.—The only essential oil varnishes used are for pictures. Picture varnishes should be white, light, and quite transparent, which will preserve the colours without giving them any disagreeable tint; and it should be possible to take them off the picture without injuring it. They are usually made of gum mastich and turpentine dissolved together in some essential oil. The varnish is passed through a cloth, and allowed to clarify. It is applied cold to the picture.

Varnish for Glass in order to preserve it from the Rays of the Sun.—Pulverise a quantity of gum adragant, and let it dissolve for 24 hours in the white of eggs well beat up; then rub it gently on the glass with a brush.

Varnishes before they are used should be carefully kept from dust, which would spoil them; and they should be kept in a vessel quite clean and dry. When used, they should be lifted lightly with a brush, and spread upon a ground altogether free from dirt and moisture. The substance, after being varnished, should be exposed to the heat of the sun, or placed in a warm room covered with a glass case, to keep out all filth. Oil varnishes require more heat than alcohol varnishes. The varnish should be put on very quickly, making great strokes with the pencil or brush, taking care that these strokes never cross one another; it should be spread equally, and never thicker than a leaf of paper; a second coat should never be put on till the first is quite dry. If the varnish, after being put on, becomes dull and uneven, it must be taken off entirely, and new varnish put on.

When wainscot is to be varnished, it is first painted of a wooden colour. This colour is made by infusing in water either red or yellow ochre (according to the colour wished for), terra ombria (a kind of ochre) and white lead; into this as much as necessary is put of *parchment paste*. Two thin coats of this are to be put on, and, after they are quite dry, the varnish.

Varnishes are polished with pumice-stone and tripoli earth. The pumice-stone must be reduced to an impalpable powder, and put upon a piece of serge moistened with water; with this the varnished substance is to be rubbed lightly and equally. The tripoli must also be reduced to a very fine powder, and put upon a clean woollen cloth moistened with olive oil, with which the polishing is to be performed. The varnish is then to be wiped with soft linen, and, when quite dry, cleaned with starch or Spanish white, and rubbed with the palm of the hand or with a linen cloth.

To recover colours or varnish, and to take off the dirt and filth which may adhere to them, a ley is used made of potash and the ashes of lees of wine. Take 48 ounces of potash, and 16 of the above-mentioned ashes, and put them into six quarts of water, and the ley is made: instead of the ashes an equal quantity of potash would probably do as well. To clean dirty colours, dilute some of this ley with four times its quantity of water, and rub the picture with it; then wash it with river water; and when dry, give it a coat or two of varnish. In order to take off a varnish, wash it with the above-mentioned ley, then with water, and then lift it off the substance on which it was with any iron instrument.—We shall finish this article with a description of the famous Chinese varnish.

The Chinese varnish is not a composition, but a resin which exudes from a tree called in China *tsi-chu*, "varnish tree." This tree grows in several provinces of the southern parts of China. The Chinese take the following method of propagating this treee: In spring they choose a vigorous shoot about a foot in length, which proceeds immediately from the trunk; and coat over the lower part, by which it adheres to the tree, with a kind of yellow earth, at least three inches in thickness. This coat is carefully covered with a mat, to defend it from rain and the injuries of the air. Towards the autumnal equinox they detach a little of the earth, to observe in what condition the small roots are, which begin to spring forth from the shoot. If they find that the filaments which compose them are of a reddish colour, they judge it is time to make an amputation; but they defer it if the roots are white, because this colour shows that

that they are yet too tender: they then close up the coat again, and wait till the spring following. When the shoot is separated from the trunk of the tree, it is put into the earth; but in whatever season it is planted, whether in spring or autumn, great care must be taken to put plenty of cinders into the hole prepared for it; without this precaution the ants would destroy the yet tender roots, or at least deprive them of all their moisture, and cause them to decay.

The Chinese do not procure varnish from the tsi-chu until its trunk is nearly five inches in diameter, which size it seldom attains to before seven or eight years. Varnish extracted from a tree smaller or of less age would not have the same body and splendour. This liquor distils only in the night time, and during the summer season. To cause the gum to flow, they make several rows of incisions round the trunk, the number of which is proportioned to the vigour of the tree. The first row is seven inches from the earth, and the rest are at the same distance one from the other, and continue to the top of the trunk, and even sometimes on the boughs which are of sufficient strength and size. The Chinese use a crooked iron for making these incisions, which must run a little obliquely, and be equal in depth to the thickness of the bark; they make them with one hand, and with the other hold a shell, the edges of which they insert into the opening, where it remains without any support. These incisions are made towards evening, and next morning they collect the varnish which has fallen into the shells; the following evening they are again inserted, and this operation is continued until the end of summer. A thousand trees yield almost in one night 20 pounds of varnish.

While the varnish distils, it exhales a malignant vapour, the bad effects of which can only be prevented by preservatives and great precaution. The merchant who employs the workmen is obliged to keep by him a large vase filled with rape-oil, in which a certain quantity of those fleshy filaments have been boiled that are found in hog's lard, and which do not melt. When the workmen are going to fix the shells to the trees, they carry some of this oil along with them, and rub their face and hands with it, which they do with greater care when they collect in the morning the varnish that has distilled during night. After eating, they wash their whole bodies with warm water, in which the bark of the chesnut tree, fir wood, crystallized saltpetre, and some other drugs, have been boiled. When they are at work near the trees, they put upon their heads a small cloth bag in which there are two holes, and cover the fore part of their bodies with a kind of apron made of doe-skin, which is suspended from their necks with strings, and tied round them with a girdle. They also wear boots, and have coverings on their arms, made of the same kind of skin. The labourer who should attempt to collect varnish without using this precaution, would soon be punished for his rashness, and the most dreadful effects would ensue. The disorder shows itself by tetters, which become of a bright red colour, and spread in a very short time; the body afterwards swells, and the skin bursts and appears covered with an universal leprosy. The unhappy wretch could not long endure the excruciating pain which he feels, did he not find a speedy remedy in those preservatives which are used against the malignant and noxious exhalations of the varnish.

The season of collecting varnish being ended, the merchants put it into small casks closely stopped. A pound of it newly made costs him about one shilling and eight pence sterling; but he gains cent. per cent. upon it, and sometimes more, according to the distance of the place to which he transports it.

Besides the lustre and beauty which that varnish gives to many of the Chinese manufactures, it has also the property of preserving the wood upon which it is laid, especially if no other matter be mixed with it. It prevents it from being hurt either by dampness or worms.

Every workman has a particular art and method of using the varnish. This work requires not only much skill and dexterity, but also great attention, to observe the proper degree of fluidity which the gum ought to have, as it must be neither too thick nor too liquid when it is laid on. Patience above all is necessary in those who wish to succeed. To be properly varnished, a work must be done at leisure; and the whole summer is scarcely sufficient to bring it to perfection. It is therefore rare to see any of those cabinets which are imported to us from Canton so beautiful and durable as those manufactured in Japan, Tong-king, and Nang-king, the capital of the province of Kiang-nan: not that the artists do not employ the same varnish; but as they work for Europeans, who are more easily pleased, they do not take the trouble of giving the pieces which come from their hands all the polish they are capable of receiving.

There are two methods of laying on the varnish; the simplest is, when it is immediately laid on the wood. The work is first polished, and then daubed over with a kind of oil which the Chinese call *tong-yeou*. When this oil is dry, it receives two or three coats of varnish; which remain so transparent, that all the shades and veins of the wood may be seen through them. If the artist is desirous of entirely concealing the substance on which they are laid, nothing is necessary but to add a few more coats; these give the work a shining surface, the smoothness of which equals that of the most beautiful ice. When the work is dry, various figures are painted upon it in gold and silver, such as flowers, birds, trees, temples, dragons, &c. A new coat of varnish is then sometimes laid over these figures, which preserves them, and adds much to their splendour. The second method requires more preparation. The Chinese workmen fix to the wood by means of glue a kind of pasteboard, composed of paper, hemp, lime, and other ingredients, well beaten that the varnish may incorporate with them. Of this they make a ground perfectly smooth and solid, over which the varnish is laid in thin coats, that are left to dry one after the other.

It often happens, that the lustre of varnished tables and other pieces of furniture is insensibly destroyed by tea and warm liquors. "The secret of restoring to varnish its shining black colour (says a Chinese author) is to expose it for one night to a white hoar-frost, or to cover it some time with snow." For a method of imitating *Chinese varnish*, see TURNING.

VARNISH also signifies a sort of shining coat, wherewith potters-ware, delft-ware, china-ware, &c. are covered, which gives them a smoothness and lustre. Melted lead is generally used for the first, and smalt for the second. See GLAZING.

VARNISH, among medalists, signifies the colours antique medals have acquired in the earth.

The beauty which nature alone is able to give to medals, and art has never yet attained to counterfeit, enhances the value of them: that is, the colour which certain soils in which they have a long time lain tinges the metals withal: some of which are blue, almost as beautiful as the turquoise; others with an inimitable vermilion colour; others with a certain shining polished brown, vastly finer than Brasil figures. The most usual varnish is a beautiful green, which hangs to the finest strokes without effacing them, more accurately than the finest enamel does on metals. No metal but brass is susceptible of this; for the green rust that gathers on silver always spoils it, and it must be got off with vinegar or lemon juice.

Falsifiers of medals have a false or modern varnish, which they use on their counterfeits, to give them the appearance or air of being antique. But this may be discovered by its softness.

VARRO, MARCUS TERENTIUS, the most learned of all the Romans, was born 28 years B. C. He was a senator of the first distinction, both for birth and merit; and bore many great offices. He was an intimate friend of Cicero; and this friendship was confirmed and immortalized by a mutual dedication of their learned works to each other. Thus Cicero dedicated his Academic Questions to Varro; and Varro dedicated his treatise on the Latin tongue to Cicero. In the civil wars he was zealously attached to Pompey; but after his defeat soon submitted to Cæsar, who was reconciled to him. Afterwards he applied his whole time to letters, and had the charge of the Greek and Latin libraries at Rome. He was above 70 when Antony proscribed him; however, he found means to escape and save his life, though he could not save some of his works and his library from being plundered by the soldiers. After this storm was over, he pursued his studies as usual; and Pliny relates, that he continued to study and to write when he was 88 years of age. He was 80 when he wrote his three books *De re Rustica*, which are still extant. Five of his books *De lingua Latina*, which he addressed to Cicero, are all extant. There remain, too, divers fragments of his works, particularly of his Menippean Satires, which are medleys of prose and verse; and Scaliger has collected some of his epigrams from among the *Catalecta Virgilii*. His books *De lingua Latina*, and *De re Rustica*, were printed with the notes of Joseph Scaliger, Turnebus, and Victorius, by Henry Stephens at Paris, 1573, in 8vo, and have been published separately since among the *Auctores de lingua Latina*, and the *Auctores de re Rustica*.

There was another Varro of antiquity called *Atacinus*, a poet, who was born about 10 years after the first, at a small town near Narbonne. His chief works were, A poem on the war with the Sequani, a people of Gaul; and the Astronomics, that went under the name of Planciades the grammarian. But the *Argonautics*, in four books, was what gained him the greatest reputation: and though indeed nothing but a translation of Apollonius Rhodius, yet was so well done as to be commended by Quintilian.

VARRONIA, a genus of plants belonging to the class pentandria, and arranged in the natural system under the 41st order, *Asperifoliæ*. See BOTANY *Index*.

VASCULAR, something consisting of divers vessels, as arteries, veins, &c.

VASE, a term frequently used for ancient vessels dug from under ground, or otherwise found, and preserved in the cabinets of the curious. In architecture, the appellation *vase* is also given to those ornaments placed on corniches, focles, or pedestals, representing the vessels of the ancients, particularly those used in sacrifice, as incense-pots, flower-pots, &c. See PORTLAND-*Vase*.

VASSAL, in our ancient customs, signified a tenant or feudatory; or person who vowed fidelity and homage to a lord, on account of some land, &c. held of him in fee; also a slave or servant, and especially a domestic of a prince.—*Vassallus* is said to be *quasi inferior socius;* as he is inferior to his master, and must serve him; and yet he is in a manner his companion, because each of them is obliged to the other. See FEODAL *System*.

VATICAN, a magnificent palace of the pope in Rome, which is said to consist of several thousand rooms: but the parts of it most admired are the grand staircase, the pope's apartment, and especially the library, which is one of the richest in the world, both in printed books and manuscripts.

VAUBAN, SEBASTIAN LE PRESTRE, SEIGNEUR DE, marshal of France, and the greatest engineer that country ever produced, was born in 1633. He displayed his knowledge of fortification in the course of many sieges, and his services were rewarded with the first military honours. He was made governor of Lisle in 1668, commissary general of the fortifications of France in 1678, governor of the maritime parts of Flanders in 1689, and a marshal of France in 1703. He died in 1707, after having brought the arts of attacking and defending fortified places to a degree of perfection unknown before. His writings on these subjects are in great esteem.

VAUCLUSE, a department in the south-east of France, lying between the eastern side of the Rhone, and the branches of the Alps. The soil is various, in the north chiefly calcareous, in the west sandy, and in other parts covered with flinty pebbles. Agriculture is in a very rude state, the corn raised is not sufficient for internal consumption, and leguminous plants do not thrive here. The climate admits of the vine, the olive, and the mulberry, but none of them are cultivated with any degree of spirit. There are mines of coal, but of a kind extremely sulphurous. The manufactures are trifling. The extent of this department is 234,560 hectares, and the population in 1817 was 205,832. Avignon is the chief town.

VAUDOIS, VALDENSES, or *Waldenses*, in ecclesiastical history, a name given to a sect of reformers, who made their first appearance about the year 1160.

The origin of this famous sect, according to Mosheim, was as follows: Peter, an opulent merchant of Lyons, surnamed *Valdensis*, or *Validisius* from Vaux or Waldum, a town in the marquisate of Lyons, being extremely zealous for the advancement of true piety and Christian knowledge, employed a certain priest called *Stephanus de Evisa*, about the year 1160, in translating from Latin into French the four Gospels, with other books of Holy Scripture, and the most remarkable sentences of the ancient doctors, which were so highly esteemed

esteemed in this century. But no sooner had he perused these sacred books with a proper degree of attention, than he perceived that the religion which was now taught in the Roman church, differed totally from that which was originally inculcated by Christ and his apostles. Struck with this glaring contradiction between the doctrines of the pontiffs and the truths of the Gospel, and animated with zeal, he abandoned his mercantile vocation, distributed his riches among the poor (whence the Waldenses were called *poor men of Lyons*), and forming an association with other pious men, who had adopted his sentiments and turn of devotion, he began in the year 1180 to assume the quality of a public teacher, and to instruct the multitude in the doctrines and precepts of Christianity.

Soon after Peter had assumed the exercise of his ministry, the archbishop of Lyons, and the other rulers of the church in that province, vigorously opposed him. However, their opposition was unsuccessful; for the purity and simplicity of that religion which these good men taught, the spotless innocence that shone forth in their lives and actions, and the noble contempt of riches and honours, which was conspicuous in the whole of their conduct and conversation, appeared so engaging to all such as had any sense of true piety, that the number of their followers daily increased.—They accordingly formed religious assemblies, first in France, and afterwards in Lombardy, from whence they propagated their sect throughout the other provinces of Europe with incredible rapidity, and with such invincible fortitude, that neither fire, nor sword, nor the most cruel inventions of merciless persecution, could damp their zeal, or entirely ruin their cause.

VAULT, in *Architecture*, an arched roof, so contrived that the stones which form it sustain each other.

Vaults are on many occasions to be preferred to soffits or flat ceilings, as they give a greater height and elevation, and are besides more firm and durable.

VAYER. See MOTHE.

VAYVODE, or VAIVODE. See WAYWODE.

UBES, ST, a sea-port town of Portugal, in the province of Estremadura, seated on a bay of the Atlantic ocean, 21 miles south of Lisbon. It stands on an eminence, with a very strong castle built on a rock. The soil around is fertile in corn, wine, and fruits; and it is furnished with good fish from the sea, and a small lake in the neighbourhood. Here great quantities of fine salt are made, which is carried to the American plantations. E. Long. 8. 54. N. Lat. 38. 22.

UBIQUITARIANS, formed from *ubique*, "everywhere," in ecclesiastical history, a sect of Lutherans which rose and spread itself in Germany; and whose distinguishing doctrine was, that the body of Jesus Christ is everywhere, or in every place.

Brentius, one of the earliest reformers, is said to have first broached this error, in 1560. Luther himself, in his controversy with Zuinglius, had thrown out some unguarded expressions, that seemed to imply a belief of the omnipresence of the body of Christ; but he became sensible afterwards, that this opinion was attended with great difficulties, and particularly that it ought not to be made use of as a proof of Christ's corporal presence in the eucharist. However, after the death of Luther, this absurd hypothesis was renewed, and dressed up in a specious and plausible form by Brentius, Chemnitius, and Andræas, who maintained the communication of the properties of Christ's divinity to his human nature. It is indeed obvious, that every Lutheran who believes the doctrine of consubstantiation (see SUPPER *of the Lord*), whatever he may pretend, must be an Ubiquitarian.

UBIQUITY, OMNIPRESENCE; an attribute of the Deity, whereby he is always intimately present to all things; gives the *esse* to all things; knows, preserves, and does all in all things.

UDDER, in comparative anatomy, that part in brutes wherein the milk is prepared, answering to the mammæ or breasts in women. See ANATOMY, COMPARATIVE.

VEDAS, the sacred books of the Hindoos, believed to be revealed by God, and called *immortal*. They are considered as the fountain of all knowledge human and divine, and are four in number; of which we have the following account in the first volume of the Asiatic Researches: the *Rigveda* consists of five sections; the *Yajurveda* of eighty-six: the *Samaveda* of a thousand; and the *At'harvaveda* of nine; with eleven hundred *sac'ha's*, or branches, in various divisions and subdivisions. The *Vedas* in truth are infinite; but have been long reduced to this number and order; the principal part of them is that which explains the duties of man in a methodical arrangement; and in the fourth is a system of divine ordinances.

From these are reduced the four *Upavedas*, the first of which was delivered to mankind by BRAHMA, INDRA, DHANWANTARI, and five other deities; and comprises the theory of disorders and medicines, with the practical methods of curing diseases.

The second consists of music, invented for the purpose of raising the mind by devotion to the felicity of the Divine nature; the third treats of the fabrication and use of arms; and the fourth of *sixty-four* mechanical arts. Of however little value we may esteem the mechanical arts of the Hindoos, and however despicable their theological system may really be, the *Upaveda*, which treats of diseases and the method of curing them, surely deserves to be studied by every European physician practising in India. There are indeed a great number of medical books in the Shanscrit language worthy of attention; for though the theories of their authors may be groundless and whimsical, they contain the names and descriptions of many Indian plants and minerals, with their uses, discovered by *experience*, in the cure of diseases.

VEDETTE, in *War*, a centinel on horseback, with his horse's head towards the place whence any danger is to be feared, and his carabine advanced, with the butt-end against his right thigh. When the army has encamped, there are vedettes posted at all the avenues, and on all the rising grounds, to watch for its security.

To VEER *and* HAUL, to pull a rope tight, by drawing it in and slackening it alternately, till the body to which it is applied acquires an additional motion, like the increased vibrations of a pendulum, so that the rope is straitened to a greater tension with more facility and dispatch. This method is particularly used in bauling the bowlines.

The wind is said to veer and baul when it alters its direction, and becomes more or less fair. Thus it is said to veer aft and to haul forward.

VEER, *Ter-Veer*, anciently *Camp-Veer*, a town of Zealand in the United Provinces, standing at the mouth of the East Schelde, about four miles from Middleburgh, and eight from Flushing. Veer, in Dutch, signifies a passage or ferry over an arm of the sea or a river; and as there was once a ferry here over the Schelde to the village of Compen, on the island of North Beveland, the town thereby got the name of *Veer*, *Camp-Veer*, and *Ter-Veer*. It is well fortified, and formerly enjoyed a good trade, especially to Scotland; the natives enjoying particular privileges here. The harbour is very good, and the arsenal the best furnished in the world. Hence the Veres, anciently earls of Oxford, are said to have derived both their origin and name.

VEERING, or WEARING, the operation by which a ship, in changing her course from one board to the other, turns her stern to windward. Hence it is used in opposition to TACKING, wherein the head is turned to the wind and the stern to leeward. See SEAMANSHIP.

VEGA, LOPEZ DE, a celebrated Spanish poet. He was the son of Felix de Vega and Francisca Fernandez, who were both descended from honourable families, and lived in the neighbourhood of Madrid. Our poet was born in that city on the 25th of November 1562. He was, according to his own expression, a poet from his cradle; and beginning to make verses before he had learned to write, he used to bribe his elder school-fellows with part of his breakfast, to commit to paper the lines he had composed. Having lost his father while he was yet still a child, he engaged in a frolic very natural to a lively boy, and wandered with another lad to various parts of Spain, till, having spent their money, and being conducted before a magistrate at Segovia for offering to sell a few trinkets, they were sent home again to Madrid. Soon after this adventure, our young poet was taken under the protection of Geronimo Manrique, bishop of Avila, and began to distinguish himself by his dramatic compositions, which were received with great applause by the public, though their author had not yet completed his education: for, after this period, he became a member of the university of Alcala, where he devoted himself for four years to the study of philosophy. He was then engaged as secretary to the duke of Alva, and wrote his Arcadia in compliment to that patron: who is frequently mentioned in his occasional poems. He quitted that employment on his marriage with Isabel de Urbina, a lady (says his friend and biographer Perez de Montalvan) beautiful without artifice, and virtuous without affectation. His domestic happiness was soon interrupted by a painful incident: Having written some lively verses in ridicule of a person who had taken some injurious freedom with his character, he received a challenge in consequence of his wit; and happening, in the duel which ensued, to give his adversary a dangerous wound, he was obliged to fly from his family, and shelter himself in Valencia. He resided there a considerable time; but connubial affection recalled him to Madrid. His wife died in the year of his return. His affliction at this event led him to relinquish his favourite studies, and embark on board the Armada which was then preparing for the invasion of England. He had a brother who served in that fleet as a lieutenant; and being shot in an engagement with some Dutch vessels, his virtues were celebrated by our afflicted poet, whose heart was peculiarly alive to every generous affection. After the ill success of the Armada, the disconsolate Lopez de Vega returned to Madrid, and became secretary to the marquis of Malpica, to whom he has addressed a grateful sonnet. From the service of this patron he passed into the household of the count of Lemos, whom he celebrates as an inimitable poet. He was once more induced to quit his attendance on the great, for the more inviting comforts of a married life. His second choice was Juana de Guardio, of noble birth and singular beauty. By this lady he had two children, a son who died in his infancy, and a daughter named *Feliciana*, who survived her father. The death of his little boy is said to have hastened that of his wife, whom he had the misfortune to lose in about seven years after his marriage. Having now experienced the precariousness of all human enjoyments, he devoted himself to a religious life, and fulfilled all the duties of it with the most exemplary piety: still continuing to produce an astonishing variety of poetical compositions. His talents and virtues procured him many unsolicited honours. Pope Urban VIII. sent him the cross of Malta, with the title of Doctor in Divinity, and appointed him to a place of profit in the Apostolic Chamber: favours for which he expressed his gratitude by dedicating his *Corona Tragica* (a long poem on the fate of Mary queen of Scots) to that liberal pontiff. In his 73d year he felt the approaches of death, and prepared himself for it with the utmost composure and devotion. His last hours were attended by many of his intimate friends, and particularly his chief patron the duke of Sessa, whom he had made his executor; leaving him the care of his daughter Feliciana, and of his various manuscripts. The manner in which he took leave of those he loved was most tender and affecting. He said to his disciple and biographer Montalvan, That true fame consisted in being good: and that he would willingly exchange all the applauses he had received to add a single deed of virtue to the actions of his life. Having given his dying benediction to his daughter, and performed the last ceremonies of his religion, he expired on the 25th of August 1635.

VEGETABLE PHYSIOLOGY.—Under the article BOTANY, and also under PLANT, we have already delivered some of the commonly received doctrines on this subject. But as some late investigations seem to lead to new views with regard to the structure and nature of vegetables, we have thought it necessary to resume the subject, and to give as full a detail of the experiments and observations to which we allude as our limits will permit; we shall first treat of the structure, and secondly of the physiology of plants.

I. STRUCTURE OF PLANTS.—In considering the stucture or anatomy of plants, we shall treat, 1st, of the root; 2d, of the stem and branches; 3d, of the leaves; and 4th, of the flowers; in the order in which they are now enumerated.

1. *The Root.*—The root is that organ belonging to vegetables by which they are supplied with nourishment, and by which they are fixed to a commodious situation.

It was formerly supposed to be composed of outer and inner bark, of wood, and of pith; but Mrs Ibbetson, who has lately communicated * to the public the results of an elaborate

* Nich. Jour. xiii. 161. and 334.

elaborate series of experiments on this subject, thinks that it is wholly composed of the rind much thickened, with perhaps a very little of the outer bark, but no inner bark; of a quantity of wood, hardly any pith, and no spiral vessels. Mrs Ibbetson searched in vain for the larger vessels of the inner bark, till it occurred to her that the want of this bark accounted for there being no leaves on the root. Mrs Ibbetson had often been assured that roots were found bearing leaves, but on dissection of these supposed roots, she found that they were branches which crossed the root.

The root consists of the caudex, stock or main body, and of the radiculæ or fibres which arise from the caudex, and are the organs by which the moisture is immediately imbibed.

In botanical terminology, we generally consider all that part of a plant which is under ground as the root; but Linné comprehends under his definition, what we term the body or trunk of the plant; and he went so far as to call the stems of trees "*roots above ground;*" but as Dr Smith justly remarks, this seems paradoxical and scarcely correct. Dr Smith adds, that perhaps it would be more accurate to call the caudex a *subterraneous stem*; although he is rather inclined to think that it has functions distinct from the stem, analogous to digestion; for there is evidently a great difference in many cases, between the fluids of the root, at least the secreted ones, and those of the rest of the plant.

In botanical physiology, by the term *root*, is often understood the parts only which serve to keep the plants firm in the ground: thus the bulbous and fleshy roots as they are called, are, strictly speaking, not roots; the radiculæ or fibres being the real roots. The duration of roots is various; they are either annual, biennial, or perennial.

2. *The Stems and Branches.*—Linné long ago divided the stems of trees into four parts; the rind, the bark, the wood and the pith: and nearly a similar division has been adopted by most vegetable physiologists till the present time.

Mrs Ibbetson (aided by a powerful solar microscope), however, thinks that nature points out a more regular division, a division marked not only by the form, but by the difference of the *juices*, with which the parts are swelled.

Mrs Ibbetson divides the stem of trees into six parts; 1. The rind; 2. The bark and inner bark; 3. The wood; 4. The spiral nerves; 5. The nerves or circle of life (corona of Hill); and, 6. The pith.

Of the rind.—Mrs Ibbetson conceives the rind to be merely an outward covering to the tree, which prevents its juices from being evaporated by the influence of the sun's heat. The rind is continued under ground: but it may be as useful there to prevent the entrance of the dust and earth, the pressure of stones, or the injury of insects.

The rind is composed of two rows of cylinders, with a single line to divide them. The cylinders are filled with a pellucid liquor. There are seldom more than four or five layers of vessels in the rind; but it is in general so covered with parasitic plants, as powdery lichens, &c. that its thickness is often more than doubled.

The rind does not appear to be necessary to plants in general, as there are many in which the bark serves as a covering in its stead; but it seems to form an essential part of trees.

2. *Of the bark and inner bark.*—These parts, though certainly different as to *form*, contain the same kind of juice; and being so nearly allied, may be treated of as one. From the bark and inner bark the leaves take their origin, as will be shown when we come to treat of the formation of the leaf-bud. Mrs Ibbetson conceives that the juice of the bark is the blood of the tree.

In the bark alone are produced the gums, the resins, the oil, the milk, &c.; in short all that belongs to the tree; gives taste to it; all that makes one plant differ from another, and all its virtues, if the expression may be used. The bark is generally green; the inner bark white, yellow, or green. The former consists of vessels crossing each other; the latter of bundles of vessels of two sizes. The large vessels consist of broad cylinders, having a bottom with a hole in it, through which the liquid passes, though not with perfect ease.

Mrs Ibbetson says that on exposing several pieces of the inner bark to the solar microscope, the moment she turned the light on the specimen, the juice, which had before proceeded up the pipes rather slowly, was suddenly propelled forward with a force truly astonishing.

When the heat and light were increased by causing the focus of the rays to fall on the vessels, the side divisions of the vessels were broken through, thus inundating the specimen; but when a proper degree of light and heat was kept up, it was curious to observe the liquid passing from pipe to pipe, in one regular and easy flow, making only a short stop as it issued through the straitened apertures at the bottom of the vessels. Mrs Ibbetson has often stood for more than an hour watching the current, (which passes, however, much slower than the sap does), nor could she perceive while the heat and light were on it, that it required any additional expedient to hasten its momentum; but during the cold and darkness of night, she supposes that the pressure of the bastard grain mentioned by Mr Knight, may very likely assist its flow, as it is at night that the bastard grain is pressed against the cylinders.

The bastard grain is found however only in the wood; but the contraction at the bottom of the large vessels of the inner bark, may probably serve the same purpose, the impetus of the current being increased by the lessening of the apertures of the vessels.

The vessels of the inner bark are very thick in proportion to their size, and there is placed in them a peculiar circular body, which resembles a cullender full of holes so small that no liquid could pass them. In viewing the thick juice which runs through these pipes, Mrs Ibbetson observed many bubbles of air, the size of which was increased or diminished according to the temperature; and as their size varied, so was the flow of the liquid accelerated or retarded. To see these vessels well, the specimens may be placed in a basket which is to be fastened in a running stream for some time, or boiled thoroughly, and then thrown into green wax perfectly melted.

Mirbel says that "some plants have the same juices in every part of them:" but Mrs Ibbetson does not coincide with his idea, for she did not find it to be so; though the potent smell of the liquid belonging to the bark often extends to other parts of the plant, yet it generally vanishes if kept separate for a day, or becomes so faint

faint in comparison with the real liquid of the bark as to prove that it does not form an ingredient of these parts. Mirbel says that the cylinders of the inner bark are merely vacancies of the ordinary vessels; but Mrs Ibbetson states that they are exactly the same as these vessels, and occupy the same place.

They have a peculiar shape, being unlike any other vessels of the tree, and they perform a particular office.

The vessels of the bark are smaller, and more simple than those of the inner bark, and are divided by a line or two, running longitudinally between them.

3. *Of the Wood.*—This is a very obvious part. Place the stem of any plant in a coloured liquid, and every vessel which conveys the sap from the earth to the top of the tree will be tinged.

The sap is a thin watery liquor, probably medicated from the earth, in order to become suitable for the life of vegetables.

Mrs Ibbetson supposes that the sap may vary with the soil, though on trial she has never found that change which might have been suspected.

If we make a transverse section of the stem of a tree, two different kinds of layers present themselves in the wood; some running in a circular manner, which timber merchants call the *silver grain;* and others from the circumference to the centre, which they denominate the *bastard grain.* Linné long ago believed that one of the circular layers was added to the tree each year. This opinion has often been controverted, and among others by Duhamel and Mirbel; but Mrs Ibbetson has had an opportunity of verifying the accuracy of Linné's opinion. She also observed that the layer was large or small according to the exposure of the tree, and the favourableness of the season: thus in exposed situations, the circles taken as a whole, were much narrower than in trees not exposed. In some trees she noticed only half a circular layer.

Mrs Ibbetson thinks the bastard stripe consists of two lines or strings with a little scale between them; and they appear, from their extreme susceptibility, to be formed of the same leather-like substance as the spiral vessels, which we are immediately to notice.

Mr Knight merely calls them *scales;* but as he mentions their pressing close (which they certainly do) to the cylinders at night, and during cold weather, it is obvious (whichever of the opinions we adopt) that the bastard grains are capable of supplying the place of the sun's rays, by their pressure.

The wood-vessels are far more simple in structure than those of the bark; they are very narrow cylinders, and the two rows next to the corona are covered by the spiral vessels.

It is indeed difficult to determine the exact extent of the spiral vessels even with the assistance of the solar microscope, for it is by *unwinding* them alone that they can be known; and their extreme fineness confuses, in consequence of which they have been taken for sap vessels. Neither Mr Knight nor Mirbel was led into this mistake, and Mrs Ibbetson thinks that there can be no doubt that these vessels (formerly so called) are solid strings which hold no liquid.

The vessels of the wood may be best seen in slices of the stems of young trees; and if not very visible when recently cut, they will soon become so if the slices are kept in a dry place.

If the wood-vessels are cut longitudinally and observed with a high magnifier, as soon as the light is permitted to come on the glass, the flow of sap will be accelerated, and with perfect ease will run up vessels so diminutive that to measure them is almost impossible.

A few of the wood-vessels are separated and run with the spiral vessels to each leaf, in order to nourish it, as will be more particularly noticed, when we come to treat of the leaf-bud.

But little of the sap, however, passes off in this way from the principal current, which flows on; its chief purpose being to form the stamen and the pollen appertaining to it, and afterwards to lend its principal aid to the formation of the fruit and seed.

4. *The spiral vessels* are a quantity of solid strings coiled up into a spiral form. Mrs Ibbetson supposes them to be formed of a leather-like substance, and, as already mentioned, to be rolled round the wood. In this spiral manner they run up the stems of trees and plants of every kind (with a few exceptions), and from thence into every leaf and flower. These spiral cords are singly too small to be observed by the naked eye. They run into every fibre of the leaf, and are fastened to its edges, thus crossing among the vessels in every direction like a spider's web; by which disposition they can draw the leaves in any way that is necessary for them.

The larger of the interior wood-vessels are each supplied with sets of ten or twelve spiral cords, but the smaller of these have only three or four to each.

In the cabbage leaf and in the burdock, the spiral cords may be found in bundles almost as thick as a packthread, but in smaller leaves they are properly proportioned. These spiral cords, Mrs Ibbetson thinks, are the cause of the motions of plants. See PLANT, p. 601, where these cords are called *air-vessels.*

5. *Of the corona or circle of life.*—The next part to be noticed is the small circle of vessels situated between the wood and the pith, the importance of which, in the formation of the seed, will be noticed under *Impregnation of the Seed;* where are also related strong proofs to show that a plant cannot exist a day without the corona, and that if a young plant be deprived of this part, it will not grow again, though it will certainly do so if the plant be somewhat old. It is very curious that almost every botanical anatomist should have figured this part, without giving it a name, or noticing it particularly; and that these anatomists should have attributed all its powers to the pith, which, from the short term of its existence, and its being perpetually impeded in its progress to make way for the flower-bud, can evidently have but little influence. The circle of life, however, has not escaped the notice of Hill, who termed it the corona.

The circle of life consists of rows of little cylinders which have their own peculiar juice, generally of an austere quality. From the corona all branches take their rise, and from it all wood threads grow. The cylinders of which it is composed run up into all flower-buds, but never approach the leaf-bud as is represented by fig. 1. and 2.; when these cylinders enter the flower-bud, they make their way distinctly to each separate flower, Plate DXLI. fig. 1, 2.

flower, forming the pistil, and after depositing in each side the *line*, which is the first origin of life, they are afterwards impregnated, or acquire the power of giving life by the juice of the stamen, which runs through the same string into the seed.

That the principal *vitality* of the plant resides in the corona, we think is proved by the experiments and observations of Mrs Ibbetson under *Impregnation of seed*, and seems to be farther confirmed by the following remarks.

When a branch is cut from a tree, or a tree is torn up, the corona or circle of life is the first part that dies; and if, after a sudden frost, we examine the flowers of a fruit tree, we shall find that neither the calyx, the corolla, the stamina, nor the seeds are hurt, but that the pistilla are destroyed. And if we now observe the pistils with care, we shall see that it is the *line of life* which is decayed, and that this is the first part in which mortification commences. The peculiar liquor of the pistil acquires a blood-red colour, and the vessels which run up to the stigma become black, instead of their natural yellow colour.

If in wood, this line is injured (either by the decay of the bark or other means) the circle will undulate into a thousand forms, for the purpose of regaining a healthy situation in which it may pursue its course.

Mrs Ibbetson, to prove the power of the circle of life, relates the following observations respecting the *poa reptans*.

She had often measured in winter, seven or eight yards of this grass, which appeared perfectly dead; and yet in May or June, she perceived life in it at the most distant end from the stalk. Next spring she took up two of these creeping branches which were much alike; and on dissecting one of them through its whole length, she found in it a collection of little vessels not thicker than a very fine thread.

This collection of vessels had run about half way the length of the branch, which was about three yards.

Mrs Ibbetson having merely opened the cover of the grass, laid it down again, and the little vessels continued increasing till they reached the end of the branch, when they made a stop, and it was perceived that the grass began to thicken; and at the end nearest the roots, the dead part became inflated with juice, lost by degrees its dead appearance, thickened about the joints within, and at last shot forth fresh leaves and fresh roots from every joint.

Mrs Ibbetson has since watched with the greatest care, and found that the fine thread which runs through the grass protected by the dead scale, was the circle of life. When this thread is stopped by the covers decaying, it waits till the season permits the rest of the plant to grow. From what has been said, it is evident that the dead matter may be inflated with a living juice, and live itself again, provided the life near the stem of the plant be not extinguished. Mrs Ibbetson has observed this to happen in many plants, as in hydrangea, in which the stalks apparently lie down and are inflated again, or at least a part of them.

6. *Pith.*— Linné considered the pith of plants as of equal importance with the spinal marrow of animals; but Mrs Ibbetson thinks this part of but little consequence, and transfers this importance to the circle of life, which she compares to the brain and spinal marrow. She conceives that the pith forms merely a source of moisture for the plant when required. The pith stops with every flower-bud, and begins again to grow as soon as the bud is past; it decreases as the strength and size of the tree increase; it is the only part of the tree which is devoid of vessels; it is merely a net, not a bundle of cylinders, and is commonly of a remarkably splendid or silver white colour.

It has been said that the pith assumes a variety of figures, but Mrs Ibbetson thinks this is a mistake, though she admits a few different sorts.

All young trees and shrubs are provided with pith; but in the progress of their growth they need it no longer, the wood being a good substitute. On the same account, in general, we find no pith in water plants, which have a hollow stem, and rarely suffer from draught.

Linné thought that the pith was the seat of life and the source of vegetation; or in a word, the primary part of the plant. Duhamel considered it as of but little importance at all. Wildenow and Knight concur with Mrs Ibbetson in regarding it as a reservoir of moisture for the young plants; and Dr Smith holds a medium opinion between that of Linné and the other authors just named.

He says "there is in certain respects an analogy between the medulla of plants, and the nervous system of animals; it is no less assiduously protected than the spinal marrow; it is branched off and diffused through the plant, as nerves through the animal. Hence it is not absurd to presume that it may in like manner give life and vigour to the whole, though by no means, any more than nerves, the organ or source of nourishment *"

* See Fig. 3. 4, and 5.

We were somewhat surprised to find that Mrs Ibbetson had not particularly noticed the cellular tissue as a distinct part to be seen in the stems of trees, as it has been long known; we shall therefore subjoin a description of it. It is a succulent cellular substance, generally of a green colour, at least in the leaves and branches. Duhamel long ago called it *envellope cellulaire*, and Mirbel, more lately, *tissue herbacé*.

Duhamel supposed that the cellular tissue formed the cuticle, or epidermis; but this is not very probable, as his own experiments show that when the cuticle is removed, the cellular integument exfoliates, at least in trees, or is thrown off in consequence of the injury, and a new cuticle, covering a new layer of the cellular tissue, is formed under the old one. This substance is very universal, even in mosses and ferns. Leaves consist almost entirely of a plate of this substance, covered on each side by the cuticle. The stems and branches both of annual and perennial plants are invested with it; but in woody plants it is dried up, and reproduced almost continually, such parts only having that reproductive power. The old layers remain, are pushed outward by the new ones, and form at length the rugged dry dead covering of the old trunks of trees. The cellular integument is a part of plants of the greatest importance; for in it the juices of plants are operated on by light, air, &c.

With regard to the branches of trees it has been already noticed, that they derive their origin from the corona; and they are composed exactly of the same parts as the trunks from which they arise.

3. *The Leaves.*—Mrs Ibbetson has, with the assistance

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Mrs Ibbetson says the truth of her assertion may be easily seen by dissecting early buds, in which, except two or three, nothing but the cotton-like vessels will be found. She asks then what could be the use of these vessels? and answers, that to put them within the bud to keep the outside warm is against nature, for it is contrary to nature. The leaf-bud in its first state consists of two or three scales, inclosing a parcel of vessels, which appear like very moist coarse cotton, but when drawn out and placed in the solar microscope, they shew themselves to be merely the vessels of the bark and inner bark elongated and curled up in various forms.

These vessels are of three kinds like the bark, &c. First, Three or four short thick ones which appear to grow from the larger vessels of the inner bark, and through which the thickened juice flows, but with this difference, that the holes are not there.

Then there are two smaller sized vessels, which exactly resemble the smaller vessels of the bark.

Mrs Ibbetson has always found the short thick kind of vessels to form the mid-rib of the leaves, and the smaller-sized vessels to compose the interlacing fibres (or vessels) of the other parts of the leaves; and from often comparing the full-grown leaf with the leaf of the bud, she feels the most thorough conviction that the latter takes its origin as above noticed. The pabulum of the leaf which lies between the vessels, is composed of that thick juice which runs in the bark or inner bark of the tree, and which does not exist in any other part of it. The pabulum differs essentially from the sap, and may be called the blood of the tree, as it possesses peculiar properties in different trees; thus it is of a gummy nature in one, of a resinous in a second, and of an oily nature in a third, &c.

Mrs Ibbetson is not certain whether the pabulum both flows forwards and in a retrograde direction; but she is convinced that the greatest part of it is taken up in forming the leaves. The pabulum of the leaf, after the vessels are arranged and crossed, grows over in bladders, making alternate layers with the smaller pipes (vessels), and with the branches of the leaf.

Mrs Ibbetson states, that she does not know any tree which gives a more convincing proof of the formation of the leaves in the bud, than may be seen in the horse chesnut (*æsculus hippocastanum*) about the month of November or December.

Several different mid-ribs may be taken out at once from the same leaf-bud, which have an innumerable number of extremely fine silken vessels fastened to or growing up from each side of them. When these vessels have become sufficiently interlaced with each other, the pabulum will begin to grow over them, in form of small bladders full of a watery juice; and then larger vessels will cross over them, which will soon be followed by another row of bladders; and a similar process will go on until the leaf has attained its proper thickness. The leaves thus formed are very small, but when once their shape is completed every part of them continues to increase in size. Fig. 6. represents the leaf-bud of the horse-chesnut, as it was examined by Mrs Ibbetson about the month of January. Fig. 6.

Mrs Ibbetson next notices the arrangement of the leaves in the buds of different trees; but we shall consider them by and bye.

The rolling, folding, or plaiting, &c. of the leaf-bud, it is observed, does not merely take place at once; but to complete the process of budding, it appears that this arrangement of the leaves is repeated several times. During this arrangement the bud-leaves are immersed in the glutinous liquor which runs in the bark (and forms the pabulum); and the pressure of the leaves is very great. By this pressure and the rolling, &c. the leaves are completed; for if a leaf be taken from the bud before this process commences, it may be compared to a piece of cloth before it is dressed; for its back will be obscured by the ends of vessels, which, had it remained *in situ*, would have been all rubbed off, except the hairs which remain on many plants.

We come now to the formation of the edge of the leaf, a curious and beautiful process.

The bud if opened will appear full of the glutinous liquor which forms the pabulum, and the leaves arranged in the manner proper to the particular tree from which the bud is taken. If one of the leaves be taken out, the edges (in whatever manner folded) will exhibit a perfect double row of bubbles, following the scollop of the edge of the leaf; and it will appear as if it were set with brilliants.

Things being in this state, all that is wanting for the completion of the leaf is the formation of the pores, now to be mentioned. Mrs Ibbetson states that in many hundred *forming leaves* which she exposed to the solar microscope, she had never once been able to see the pores; which she has often observed after the leaves have completely quitted the bud; and she is uncertain whether this is owing to the greater thickness of the young leaf, and its being covered with more hairs than it is afterwards, which obscure or conceal the pores; or whether it be caused by the upper net-work of the leaf growing last. While the upper and under cuticles of the leaf are growing, the edge of it is completing; for the bubbles generally divide, and partly dry up, leaving horny points in their stead. When the edges of the leaves are completely formed, they burst from the bud and assume a different aspect.

The vessels of the leaves (those confined within the mid ribs and side ribs of the leaves) are of two sorts, the spiral, and the nourishing. The spiral vessels are those corkscrew-like wires which surround the two last rows of the sap vessels. The nourishing vessels are the only parts formed of the wood. They convey the sap necessary for the support of the leaves, and run on each side of the spiral vessels.

To prove that she has given a fair and accurate account of the formation of the leaf, Mrs Ibbetson

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son adds the following remarks. The colour of leaves, she observes, is not to be found in their substance, but in the liquid with which it is filled. The darkest green leaf that can be procured, has both its upper and under cuticles of a perfect white colour. In the cuticle the pores are to be found.

A leaf has rather a thicker net below than it has above: but this does not sufficiently account for the varieties of tints in different leaves.

The under net (or cuticle) does not lie so close to the pabulum of the leaf as the upper one; which may account for the colour not piercing so much through. When the two nets (or cuticles) are taken off, then the pabulum of the leaf appears.

The pabulum is formed of little bladders, filled with a dark-green liquid, and interlaced with vessels. When the pabulum is removed, a bed of large vessels presents itself; then a collection of bladders; which is followed by the larger lines (or veins) of the leaf. We next meet with another bed of bladders, which is covered by the under cuticle. Though the bladders differ in size and colour as well as in thickness in different leaves, yet the general arrangement is the same in most plants; but there are exceptions, as the firs, grasses, or those grassy leaves of early spring, which we have in the iris, crocus, snow-drop, &c. for their leaves are of a different nature.

But we shall now refer to the figures, which will serve to illustrate the mode of formation, &c. of the leaf-bud.

Fig. 7. 8. 9. Fig. 7. 8. 9. exhibit the commencement of the formation and growth of leaves; *a, a, a, a*, the mid rib; *b, b, b*, the young vessels appearing like cotton; *c, c*, the spiral nerves; *d*, the smaller vessels crossing each other. Fig. 10. Fig. 10. shews the formation of the pabulum; *e, e*, the fine vessels growing up each side of the mid rib; *f*, the pabulum. Fig. 11. Fig. 11. bud of the lime-tree (*tilia Europea*).

4. *Of the* FLOWERS, *including the calyx, corolla, stamina, and pistillum.*—Linné long ago expressed his opinion that each of these parts was formed from a particular part of the stem; thus the calyx was formed by the bark, the corolla by the inner bark, the stamina by the wood, and the pistilla by the pith. Linné also reckoned the pith of a plant (which he considered to be of equal importance with the spinal marrow of animals), as the sole formative organ of the whole vegetable kingdom.

Linné's idea respecting the formation of the calyx, corolla, &c. has been often refuted; but Mrs Ibbetson comes forward to defend the opinion of the illustrious author with a little modification. She does not, as already noticed, consider the pith as of great importance; she therefore says, that the corona or circle of life forms the pistil, not the pith; and thinks that each part of the stem has, when it arrives near the flower stalk, its peculiar juice.

Mrs Ibbetson, as a strong proof that the circle of life forms the pistil, says that it is to be found in all these leaves that bear the flower either on the middle or on their side; but in no other leaves.

She first observed this in the butcher's broom, where this circle leads directly up to the flower; then in scolopendrums, and afterwards in xylophyllos.

The leaves of such plants are more woody than any others, as every one may know on breaking them. In such plants also the circle of life may be traced as leading from one flower to another.

Mrs Ibbetson also thinks that all those parts which concur in forming the flower also join in forming the fruit and seed.

Mrs Ibbetson then adverts to the opinion of Wildenow, when he says, "we find in the springing flower, elongations of air-vessels, but we never see the elongations from each particular part, one forming the future calyx, another the corolla, and so forth." "For instance, in the common sun-flower (*helianthus annuus*), where in an immense large receptacle, numerous small flowers are placed, how should these elongations be able to unfold themselves into florets from the bark, inner bark, &c. through such a receptacle? There would arise a confusion amongst these small parts which is never met with."

"How should, besides, the stamina be formed in herbs, which are not ligneous, or the pistil in plants which have no pith? Every one may thus easily conceive that all these opinions are mere hypotheses, which may be refuted, even without the aid of anatomical dissection.

Mrs Ibbetson attacks Wildenow's opinion, and says that he adduces the syngenesian class to prove the accuracy of it, the class which contains the very plants that would have proved the mistake of his argument, had he dissected them.

Mrs Ibbetson then proposes the following questions to Wildenow. Why, if the nourishment of each part of the stem be not confined to each different part of the flower, does the whole arrangement of the parts *alter*, the moment it gets to the flower-stalk?

Why are there particular vessels to confine and carry the juice to each peculiar part, if it were not of consequence that this juice should touch no other places? For what purpose is the curious and artificial management in the bottom and top of a seed-vessel, which enables the dissector to say, that "there are five divisions of little vessels proceeding from the wood; I know, therefore (though I do not see it), that this must be a pentandrian flower; here is but one middle vessel proceeding from the circle of life (for the pith stops), it is therefore of the order monogynia; here are five divisions of little vessels proceeding from the inner bark, it must therefore have five petals?" Mrs Ibbetson wishes others to be convinced of these facts as well as herself. If a cut be made above or below the seed-vessel of a lily, a violet, or a tulip, she thinks conviction of her accuracy will follow. Why in cutting above or below the seed-vessel of a syngenesian flower can you directly tell, whether it belong to the order superflua, æqualis, or segregata? Look at the bottom of the seed-vessel of the *sonchus*; every *pin hole* of the vessel of the male is carried up by corresponding vessels in the outward cuticle of the seed, till it meets and joins the *ligature of the males;* and the female liquor is protruded through the inside of the seed, and is perhaps one of the strongest proofs of the impregnation of the female. In the syngenesian class (see fig. 12.), the delicacy of the vessels, which may be supposed too small for a liquid to flow through them, must not impede the belief that it does so, when we consider

sider the circulation of blood in the diminutive animal that torments the body of the flea or louse. Mrs Ibbetson says she has seen the liquor run up with the utmost celerity through the upper cuticle of a very small seed of a plant belonging to the syngenesian class, till it met the male and continued its course. It is to be understood that the juice from the corolla flows in the rest of the cuticle, and that the largest vessels are those for the *male liquor*. See fig. 12. 13.

Fig. 12. 13.

II. Physiology of Plants.—In treating this part of the subject, we propose to consider, first, the impregnation of seeds, and, second, the irritability of vegetables.

1. *The impregnation of the seed.*—The investigation of what is included under this title, forms one of the most beautiful and interesting pursuits of the vegetable physiologist. Mrs Ibbetson has communicated some curious observations on this subject. Provided with a powerful solar microscope for opaque objects, she proceeds to an examination of the seed, and the first shooting of the infant plant, or rather of the germ or vessel which precedes it; and she remarks that it is almost impossible to ascertain the exact time when the seed is first formed in the pericarp; but that she has always found it in the winter buds when they were large enough for dissection.

It is curious to observe the vessels, which, she says, may properly be called the life, tracing their way to each flower-bud: for a seed may be said to depend for perfection on two *separate moments*: the one in which the life *first enters the seed*, when the whole outward form appears to be perfected; and the second, when the impregnation of the seed takes place, by the ripening of the pollen.

But when the life enters, it leaves a little string, and remains for a long time afterwards in a torpid state. This string crosses the corculum, or heart of the seed, so called because it is the cradle of the infant plant. She then states that the seed is attached to the seed-vessel by two distinct organs, termed by the first botanists the umbilical cord, but as she thinks improperly, since they do not convey nourishment to the infant plant, which is wholly the office of the second set of vessels. We cannot agree with Mrs Ibbetson in her opinion; for although the umbilical cord of an infant contains nourishing vessels, it also contains nerves, and yet we would never think of restricting this term alone to the arteries. The first of the connecting organs Mrs Ibbetson conceives to be the circle of life, first, because without it the plant dies, and, second, because although every other part be eradicated by degrees and the circle of life be uninjured, the plant will grow again.

She has made these experiments many thousand times and with the above results. The circle of life consists of delicate simple vessels, which carry a juice of a particular nature, and may be traced in every part lying between the wood and the pith. These vessels are not to be found in the leaf-bud; for they pass by it to the female flower, where they establish a new life in the seed: a life which will enable it to grow, but not to give life without impregnation. These vessels are the life, therefore, from which all flower branches grow and all root-threads proceed. In calling these vessels the circle of life, Mrs Ibbetson says she only expresses what its office seems to denote.

Mrs Ibbetson goes on to describe the next (or second) organ by which the seed is attached to the seed-vessel. It consists of the nourishing vessels, which she is inclined to think proceed from the inner bark; at least they may certainly be traced thence after the infant plant has left the seed. When introduced, they enter not the seed at the same place as the life does; they come not into the corculum, but pass it, and spread themselves over a small spot below it, which is visibly of a different nature from the rest of the seed. In farinaceous plants this spot is yellow, and yields a milk-white juice; but in other seeds it is white, and gives a glutinous water of a sweetish taste. Mrs Ibbetson thinks it probable that the nourishing vessels come from the fruit *filled with this juice*, which medicated with that part of the seed (which very apparently dissolves), they together form a nourishment suited to the infant plant. When the seed is so far perfected, it remains in an almost torpid state, or growing very little; while the flower expands daily, and the stamens are hastily advancing to enough their perfect state.

It is now that by an almost imperceptible contraction of the lower part of the pistil, the juice is raised to the stigma (A), on which it may be seen hanging in a large glutinous drop, which never falls off. As soon, however, as the mid-day heat abates, this juice, which is peculiar to the pistil, retires again within the tube, the contraction ceasing with the heat that caused it. The same process goes on daily, till the stamina are ripe and ready to give out their interior powder to the pistil, which is always so placed as to receive the greater part of it; and as the anther (B) requires only moisture to burst it, it soon yields that fine and imperceptible dust, which quickly *melting and mixing with the before-mentioned liquid*, forms a combination of so *powerful* and *stimulating* a quality, that it no sooner runs down the interior of the style, and touches the nerve of life in the heart of the seed, than this vessel shoots forth in the most surprising degree, forming directly a species of *circular hook* within the *void;* which in less than two days is often completely filled, though it had perhaps for many weeks before lain in an absolute torpor. This circular nerve is soon covered by an excrescence that hides it; but if the corculum be divided with a fine lancet, the circular hook is discoverable, until the young plant is near leaving its cradle or seed. At the turn of the hook the cotyledons grow, and the root shoots from the covered end. The plant may be now said to lie in the seed in a contrary direction from that in which it will at a future time grow, since the root is above, and the stem below: but nature has provided for their change of place, since it is effected as they leave the seed. It has been already noticed that the nourishment of the infant plant

(A) In the journal it is said "to the pointal;" but certainly stigma is meant, for pistil and pointal are synonymous.

(B) In the journal it is called pollen, but anther must be meant.

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plant is medicated between the juice brought in the nourishing vessels, and the peculiar spot in the seed, forming a liquid which continues to abound; indeed the infant plant may be said to *repose in it*, till the root has opened the whole or part of the seed. The root then changes its direction, and runs into the earth, soon forming a number of stringy hairs, which serve as so many suckers to draw the liquid nourishment from the earth, while the plant quickly shews, by the rapid progress it makes, the advantage it receives from its change of diet; for it soon raises itself from its prostrate posture, emerges from the seed, and is now seen in its proper direction. The above account, we think Mrs Ibbetson justly remarks, affords a complete confirmation of the sexual system.

In the syngenesian orders, the pistil being mostly single, runs up from the seed; and the juice of the pistil has no other way of reaching the pointal (stigma must be here meant), but by passing through the seed, which it does without producing any effect, or filling up the vacancy at the top of the corculum. But as soon as the juice of the pistil becomes mixed with the pollen, which dissolves in it, the void of the corculum is filled, the hook is soon afterwards formed, and the plant is roused to life. Mrs Ibbetson relates some experiments which she made to ascertain whether the umbilical cord was, or was not, the life of the plant. She placed a bean in the earth, and when the infant plant was ready to leave the seed she opened it with a fine lancet, and cut off the cotyledons, just where they join the heart and the circular hook which have been before described. She then tied a piece of very fine thread round the bean, and replaced it in the earth. The cotyledons grew again, though higher up, but they appeared very weak and sickly for some time. She cut off the root of another bean which had been placed in the earth, and which was of the same age as the above, and found that the root grew again in a few days and appeared quite healthy.

In a third experiment she separated and cut off the nourishing vessels from each side of the bean; but a great number of hairs grew from the wounded part, which, by attaining moisture from the earth for nourishment, supplied the place of the vessels cut off; so that it was not ascertained whether or not the bean would live independent of these vessels, which was the object of the experiment. We observe here, however, a grand provision of nature for the embryo plant: hairs being formed to supply it with moisture when the nourishing vessels are destroyed. Mrs Ibbetson next took a bean which had been about four days in the earth, and opening it with great care took out with a fine lancet the part which she esteems the cord of life, that is, the part which crosses the corculum and shot forth on the first

Fig. 14. 15. impregnation of the plant. *o o*, fig. 14. and 15. represent the nourishing vessels of a bean; L to *n* two seminal leaves or cotyledons; *l l* the cord of life, which is more easily seen in the seed of the lily, fig. 15. *l l* crossing the empty part of the corculum. Mrs Ibbetson took a flower of the lilium genus, as having a large vessel easily attained; and being careful not to separate it from the nourishing vessels, she divided the line of life fig. 16. *l l*, cutting each thread between the seeds, and so cutting off their communication; but did not touch *o o*, which she thinks is the nourishing vessel.

The consequence was, that the seeds of this flower were never impregnated. Mrs Ibbetson next tried the effect of taking the nerve of life from the chesnut, the walnut, acorn, &c; first opening a seed without touching the nerve, that she might be certain that the opening was not the cause of its death. Fig. 17. represents the heart taken out of a seed of the chesnut; *l* is the circular hook already described; *o o* the nourishing vessels, and *l l* the line of life, which was taken out from some seeds where it crosses the heart at *m*. Fig. 18. is the seed of the gooseberry; *o* the nourishing vessels, *e* the line of life, and *m* the corculum or heart. Fig. 17. Fig. 18.

She found that all those seeds from which she took the nerve of life died; and that the others, which had been merely laid open, lived. She remarks that it is only at the beginning of life, that the plant can be killed by this process; for when older, if the nerves of life decay, they shoot out above the declining part, and run into any part of the stem that is pure, to preserve themselves. Mrs Ibbetson then states that this nerve is the source of life in very decayed trees; and is also the cause of a double pith, or at least the appearance of it, in many trees.

To observe this line of life, seeds must be examined in their first formation; for when it has done its office, it detaches itself. When the seed is boiled, the line of life and nourishing vessels mark themselves by becoming of a dark colour.

2. *Irritability of vegetables.*—In entering upon this subject, we ought to warn our readers, that very opposite opinions have been entertained respecting it; some physiologists of the greatest eminence allowing that we have satisfactory proofs of the irritability of vegetables in a variety of plants, but more particularly in the motions of the mimosæ, dionea, &c.; while others of no less respectability ascribe these motions to the influence of light, heat, or some other mechanical agent.

As neither muscles nor nerves have ever been demonstrated in the vegetable structure, of course the proofs of the irritability of vegetables are drawn from the intimate analogy which seems to exist between the motions of some plants and those of animals. Some physiologists, from observing the similarity of motions in the two kingdoms, were naturally led to ascribe them to the same cause; others, from not being able to observe the same motive organs, namely, muscles, in both kingdoms, denied that plants could possess irritability; a third set, waving the idea of irritability in the vegetable kingdom, have laboured to shew that the motions of plants depend on mechanical causes alone.

We shall first notice the observations of Mrs Ibbetson, who ascribes the motion of plants to the spiral wires which we have described. Her opinion is founded upon a number of new observations made with the solar microscope, which we shall proceed to relate.

1st, The spiral vessels are not to be found in any plants to which motion is unnecessary.

She could not observe these vessels in any of the firs, in any of the plants which spread their leaves upon the surface of the water, in any of the sea weeds (c), of the lichens, or of the grasses; and she does not think that

(c) She afterwards excepts the *confervæ*, which have motion.

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that they exist in the scolopendrums or lemnas. We would here observe that if these observations were completely true, they would certainly afford a strong proof in confirmation of her opinion; but we suspect that they are not altogether just, especially as we observe a discrepancy in the papers of Mrs Ibbetson. Thus at one part she has given us a very minute description of the spiral vessels in the runners of the *poa reptans*, and now she says they are not to be found in the grasses (D).

Mrs Ibbetson's second argument is, that if a plant whose leaves present their faces to the light, be turned so that the backs are to the sun, the leaves in a few hours will regain their former position; but if this be often repeated, although the plant will not suffer, yet the leaves will be longer at every repetition in returning to their former situation, or will cease to move at all. She accounts for this by saying, that the spiral-like elastic vessels are relaxed by the operation, and lose their power of coiling into their usual form.

Others would account for the above fact by saying that the irritability of the plant was exhausted by these repeated and unnatural actions; in the same manner as the mimosa becomes gradually less sensible to impressions when too often renewed.

Mrs Ibbetson's third argument is, that those leaves which have most motion, are provided with most spiral vessels, and have these vessels most twisted; as in the *populus tremula*.

Fourth proof. Mrs Ibbetson divided the spiral vessels of a vine leaf while growing, without touching the nourishing vessels; and from that moment it never contracted, and when placed with its back to the light, it did not alter its position, though it was long before it decayed. Both electricity and galvanism cause these leaves to contract, by affecting the spiral wires (not the cuticle), for when the leaf is deprived of these vessels it does not contract at all.

We would here remark that we suspect much, in the above experiment, that more than the spiral vessels was divided: at any rate there is very great discordance between Mrs Ibbetson's experiments and that of M. Calandrini, who found that vine leaves turned to the light when they were separated from the stem and suspended by a thread.

Fifth argument. Mrs Ibbetson observed, when she placed some of the spiral vessels taken from a cabbage leaf upon one end of a long netting needle, and caused a candle to approach, that they were much agitated, and at last flung themselves off the needle. We think no conclusion can be drawn from what is here stated.

The fresh water *conferva* and the dodder tribe, are the only plants, without leaves, that Mrs Ibbetson is acquainted with, which have spiral vessels.

Mrs Ibbetson says that the spiral vessels are so very tough, and so very tightly coiled, in the leaf stem (*petiole*) of the *geranium cordifolium*, that she has by means of them been enabled to draw up the leaf; but it is difficult to be done.

The sixth proof is drawn from the effect produced by moisture on Captain Kater's hygrometer, which will be noticed soon.

General Observations.—Mrs Ibbetson says the spiral wires may be considered as a secondary cause of motion, as they are primarily acted upon by light and moisture. By means of the spiral wire, all the movements of plants are made; by it, flowers open in the morning and shut in the evening; the leaves turn, and the creeping plants wind in their regular order. Mrs Ibbetson says, the opening of the flower at a different time of the day, or its turning in a different manner, does not militate against the above statement; as strong light and dry weather produce a contraction of the wire, while darkness and moisture effect a dilatation of it. It depends wholly upon the position in which the spiral wire is placed, whether by its dilatation the flowers shall be opened or shut, as in mechanics the same spring may be made to turn to the right or to the left, to open or to shut a box. Most of the flowers which Mrs Ibbetson has observed to close at noon, have an extremely limber corolla, formed only of a double cuticle without pabulum; and hence they are soon overcome by heat, and relaxation directly takes place; as in the *convolvulus nil*, the evening or tree primrose, &c.

We must add, however, that we regard this account of the spiral vessels with some degree of doubt. We suspect that the spiral vessels, if they have the power of opening or shutting a flower, will always act in one uniform manner; i. e. if they are able to open it, they will always do so, and *vice versa*.

The *nymphea alba* raises itself out of the water, and expands, about seven o'clock in the morning; and closes again, reposing upon the surface, about four in the evening. Now its petals are much thicker than those of the *leontodon taraxacum*, which shuts up its flowers between eight and nine in the evening.

We could multiply instances; but we conceive we have said enough to shew, that the flowers with the most slender corolla are not uniformly those which soonest close.

Mrs Ibbetson says, contrary to the opinion of Mirbel, that the case in which the spiral vessels are inclosed is capable of being stretched; indeed it is formed of so thin (or rather so loose) a substance, as plainly to be intended to dilate and contract. The case is composed of a very few thin vessels, interlaced with an extremely fine spiral wire; while the large spiral vessels fill up the case in an irregular manner, the nourishing vessels form a regular circle of tubes around it. See fig. 29. and 30.

Of the Indian grass (*andropogon contortum* of Linné), of which Captain Kater's hygrometer is formed.—The chief part of it is made with the spiral awn of an Indian grass, which readily untwists in a moist atmosphere, and *vice versa*. Now Mrs Ibbetson asks, if the most trifling change of moisture can untwist one sort of vegetable fibre, and by this means manage an instrument, why should not a quantity of similar formed fibres or spiral vessels produce the same effect on leaves and flowers? She says, Captain Kater's hygrometer moves very sensibly if a finger be placed within half an inch of the fibre (awn.) Now, the most sensitive plant we have will not move but with the touch."

We are quite aware of the effects of moisture on some vegetables.

(D) She found the spiral vessels also in the *andropogon contortum*.

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vegetables. We have strong proofs of it in some of the mosses, as in the *bryum hygrometricum*, which, if the fruitstalk be moistened at the bottom, makes three or four revolutions; if the upper part be moistened, it turns the contrary way.

We can scarcely compare these motions with those of the mimosæ; for it is quite evident that they are produced by moisture: but as we are to speak of the motions of the mimosæ in a little, we would only observe, that when Mrs Ibbetson says "the sensitive plant will not move but with the touch," she argues against herself; for this shews that it is acted upon by the same causes as animal muscles, and that it is not governed by moisture alone.

The only sensitive part of the Indian grass is the awn, which is formed of a leather-like substance, infinitely thicker and stronger than the usual spiral vessels in plants. The awn is formed of two apparently flat pieces, with a cylindric hollow running through the middle, which is filled with a thick spiral wire. Fig. 21. 22. 23. and 24. Each side of the awn is bristled; but the bristles do not add to its sensibility.

Of the Nettle.—The awn or sting of the nettle is a long pipe with a bag at the end divided into two parts; the smaller contains the poison, and the larger is situated below it. This bag seems also to be composed of a leather-like substance, and it is likewise affected by light and moisture.

The moment the upper part of the pipe is touched, the under part of the bag whirls up, breaks the poison bladder, and throws its contents violently up the pipe, burning the person who touches it.

Light thrown upon the bag by means of the solar microscope, produces the same effect as touching it. The poisonous liquor is protruded up the pipe with great force, till it issues out at the minute aperture at the point; but before it does so, the pipe is bent down with a jerk, by means of the spiral wire.

The spiral wire winds round the bag at the bottom of the pipe; and it is by the action of this wire that the bag is made to contract. The nettle lays down its stings every evening, just as the sensitive plant does its branches. See fig. 19, and 20.

Mimosa Sensitiva.—The motions of this plant are regulated not only by the spiral wire, but also by a bag of a leather-like substance, which is capable of contraction and dilatation.

We shall next give Mrs Ibbetson's plate respecting the structure of this plant, with her description.

Fig. 25. Fig. 25. is a representation of the springs which govern each leaf; *d, d* is the stalk. Each leaf has a base *c, c*, which serves to concentrate the spiral wires. These passing over in every direction, being drawn through the narrowest parts of the stem *b b b b*, press the stem together; and, when touched, lay the leaves, one on the other, the whole way down the leaf-stalk. But, before the stimulus is applied, the stem is flattened in a contrary direction. The ball of the leaf is hollow and filled with oil. The parts *e e* and *p p*
Fig. 26. (fig. 26.) are made of that leathery substance, which forms the cuticle, and is contracted by the light in the solar microscope. The parts *e e* contain the oil which serves to lubricate the knots (we suppose), and enable them to slip over each other; beside, probably, acting some important part in the formation of the various gasses and juices in the composition of the plant.

When touched, the whole string relaxes at *o o*, and lets the branch fall. This it would also do at *m*, if it were not supported by the wood-vessels turning into the leaf. Fig. 27. is the part *e c p p* uncut, and in its natural sate. Mrs Ibbetson thinks that not only the motions of this plant, but of all others, depend upon the spiral wires which contract and dilate by the action of light and moisture. She adds, that there are no spiral wires in the seminal leaves of the *mimosa sensitiva*, and that the seminal leaves have no motion whatever.

In farther illustration of this subject, we shall next present our readers with some observations by Mr Lyall, lately published in Nicholson's Journal *, respecting the irritability of the *mimosa pudica*, and some other plants.

* Vol. xxv. 92.

"It is well known (he observes), if we take a leaf of this plant, similar to what is represented (fig. 31.), and then, by means of a pair of scissars (completely dry), cut off half the pinnula A, this pinnula will contract at its joint, either immediately, or in a few seconds; its neighbour, or opposite pinnula, B, closing at the same time, or soon after.

"The pinnulæ A and B having come into contact, there is a pause, or a short cessation, of motion; but in the course of a few more seconds, the next pair of pinnulæ, CC, will also shut up, and the same will happen with every pair of pinnulæ of that pinna successively; only with this difference, that the intervals between the shutting up of each pair of pinnulæ will be shorter, the farther it is from the pinnula that was cut. After the whole of the pinnulæ of this pinna have completely closed, and a little interval, then the joint D will bend so as to allow the pinna to drop considerably.

"Nevertheless, the motion is often not so obvious in this joint, as in that to be mentioned.

"A longer pause will now intervene, in some cases so long as to make us suppose that all motion is at an end; but at length the joint E suddenly bends, and astonishes the beholder.

"The petiole F now, instead of forming an acute angle with the stem above the joint, forms a very obtuse angle with it.

"We shall now have another cessation of motion, and then the joint, H, will slightly bend; then another pause, then a shutting up of the pair of pinnula, H, and so on with the other pinnulæ, till the whole pinna is closed. The motions, however, will not be so regular in this pinna as they were in the other; for as the pinnulæ II approach, they press forward the next pair, and so on with all the rest."

These motions, the author supposes, are not occasioned by impulse; for a bit of the pinnula may be cut off almost without producing any motion.

But, allowing that a little motion were produced, it comes naturally as a question, Why does the motion become so extensive? how is the impulse communicated to the origin of the petiole? The author does not think that these questions will ever be satisfactorily answered upon mechanical principles.

He admits indeed, that a structure exists in the *mimosa sensitiva*, corresponding to what Mrs Ibbetson has described;

described; although he seems to have some doubts respecting it. He then proceeds to inquire, whether by such a structure, acted upon by heat, light, or moisture, we could possibly explain the motions of the *mimosa pudica*. "On the experiments above related, (he observes), I presume no one would say, that moisture was the cause of motion, as the scissars were quite dry."

It is to be remembered also, that this plant will perform its motions under water.

As there was no change of light, consequently this had no share in the effect. Besides, when moisture is produced (Mr Lyall certainly means darkness) in consequence of the abstraction of light, all the pinnulæ shut up at the same time; not, however in the regular order mentioned in the experiment. Neither does the motion take place from change of temperature, for the temperature was not altered.

A great many questions will here suggest themselves, as, How does it happen that the motion is produced? how does it become so extensive? how comes it that there are regular motions and pauses, &c.?

The author concludes, by saying, that it is vain to attempt any mechanical solution of the phenomenon mentioned above, "which would seem to depend on an exquisite irritability in the plant itself."

Dionæa Muscipula.—Mr Lyall does not think that the motions of this plant are to be explained in the manner spoken of by Broussonet, who ascribed them to the evacuation of a fluid from the leaf, which will be noticed when we speak of the *droseræ*. For the leaf may be touched without causing any efflux of fluid whatever, and yet it will contract completely.

Comparetti's explanation respecting the motion of this plant is not admitted; because it seems improbable, is contrary to analogy, and inadequate to explain the phenomenon.

Of the Drosera Longifolia and Rotundifolia.—As many of the muscles of the animal system, as the heart, diaphragm, &c. act quite independent of the will, and as these parts are highly irritable, Mr Lyall wishes to show, that a voluntary command of a muscular force should not be taken into the definition of the word irritability, as has been done by some. Mr Lyall says, "By irritability, I understand, that property inherent in some bodies (or rather parts of bodies), by which, when a stimulus is applied, they are enabled to contract.

The leaves of the drosera rotundifolia, when properly unfolded, lie round the stem in a stellated manner. The footstalks of the leaves vary in length from half an inch to an inch and a half. The leaves are covered on their upper surface by a number of hairs, varying also in length from one line to three-eighths of an inch, and are each terminated by a little gland, which gland is covered by a transparent viscid fluid, presenting a fine appearance.

The chief difference between the drosera longifolia and rotundifolia is in the shape of the leaves; those of the former being obovate, while those of the latter are of an orbicular shape.

Mr Lyall mentions the observations of Mr Whately, who, it would appear, was the first in this kingdom who described the contractions of the droseræ when irritated.

Mr Whately and Mr Gardom had observed some insects imprisoned in the leaves of this plant, and hence were led to press with a pin the centre of other leaves in their natural and expanded form, when they very suddenly contracted, and, as it were, encircled the pin.

Roth had noticed, in 1779, that the leaves of the droseræ moved, when irritated. He placed an ant upon the middle of a leaf of the drosera rotundifolia, but so as not to disturb the plant. The ant endeavoured to escape, but was held fast by the clammy juice of the points of the hairs, which was drawn out by its feet into fine threads; in some minutes the short hairs on the disk of the leaf began to bend, then the long hairs, and laid themselves upon the insect. After a while the leaf itself began to bend, and in some hours the end of the leaf was so bent inwards as to touch the base. The same happened when the experiments were made on the drosera longifolia, but more rapidly.

Roth also found that the hairs bent themselves when he touched them with the point of a needle, with a hog's bristle, or when he placed a very small piece of wood the weight of an ant upon the leaves.

Mr Lyall next gives us an account of his own experiments. He says, "that for five months, he almost, every day, had the species of droseræ under his eye, either at home or in the country;" and he confesses, that he never saw such a rapid contraction of the leaves of the drosera rotundifolia, as had been noticed by Messrs Whately and Gardom: but in all his experiments the contraction was gradual, though it seldom failed to happen, if the plant was in good condition. In most of his experiments an hour was necessary for the complete bending of all the hairs; and it required some hours for the perfect shutting up of the leaves. Hence it is evident, that whoever has a wish to notice the motions of the droseræ, must not set out with the expectation of seeing a rapid motion, similar to what happens in the mimosæ, follow the application of a stimulus; but, to observe the ultimate effects, must watch with an attentive eye, for at least 20 minutes.

In accounting for the manner in which these motions are performed, various opinions have been held. Broussonet suspects that the disengagement of some fluids influences them. He says, that the insect, by absorbing the fluid which is on the points of the hairs, empties the vessels of the leaf, which folds upon itself; and the quickness of the action is proportional to the number of hairs touched by the insect.

Our author observes, that "this theory, at first sight, does not appear even to be plausible; for, how is it possible that an insect can absorb a thick tenacious fluid? No doubt, however, part of this fluid will be attached to the part of the insect which touches it; but this seems quite unconnected with the contraction of the leaf. On the 30th of July, Mr Lyall brought from the country a number of plants of the drosera rotundifolia, and, on inspecting them, he found many of the hairs of the leaves deprived of their viscid fluid; but yet both they and the leaf remained quite expanded and in good condition. Next day, about four o'clock, he placed a small bit of sulphate of copper, in the disk of one of these expanded leaves, and by six o'clock most of the hairs on one side of the leaf, even the outermost, had bent themselves over the bit of copper; this seems to to prove the inaccuracy of Broussonet's theory. In other experiments, he placed small bits of bread or wood, or three or four of the central hairs, without touching the other hairs, or the viscid fluid on their ends; and in a few hours he found that all the hairs had contracted around the foreign body. In some plants, the sulphate of copper was placed upon some of the small hairs in the disk of the leaf, without touching the leaf itself; yet the bending of the hairs and leaf was complete.

"We have here proof (he adds), 1st, That the leaves do not contract when deprived of their viscid fluid, which ought to have been the case if Broussonet's theory had been true. 2dly, That the contraction takes place even when the viscid fluid does not cover the little glands. 3dly, That the contraction follows, although the foreign body is not brought into contact with all the hairs.

The opinion of Sennebier, who appears to have ascribed the motions of the droseræ to the effect of pressure is next examined. "Sennebier seems (it is observed) sensible, that the contractions of the leaves take place even when light bodies are placed on them, which circumstance of itself would lead us to suspect, that pressure is not alone the cause.

"I know (it is added), that, if we press on the centre of a leaf with a pin, &c. we may cause its margin to approximate the pin; and this certainly would be owing to a mechanical cause. But, suppose we see the contraction take place, as I have done, when a body specifically lighter than the leaf itself is placed in the centre, as a bit of rotten wood; should we be still inclined to ascribe it to a mechanical cause? Admit that it is the case. Suppose, then, we place the same bit of wood on the margin of the leaf, what effect ought to follow? If it were owing to a mechanical cause, or the weight of the foreign body, as in the last mentioned case, then we should expect, that the part of the margin of the leaf, on which the bit of wood rested, would be depressed; which undoubtedly is not the case: but, on the contrary, the margin rises, and then contracts towards the foreign body, or towards the footstalk of the leaf.

"That this motion does not depend on pressure, may be still better illustrated, by placing a fly, or some other body, on the apex of a leaf of the drosera longifolia. The hairs near the foreign body will contract around it, and then the apex of the leaf will rise upwards, and turn inwards, until it touches the base. Or, if the offending body is small, the leaf will become convoluted around it."

From the result of his experiments, the author thinks, that the motions of the leaves of the droseræ cannot be explained on mechanical principles. He conceives, that these motions are performed, if not by muscles, at least by *something* which is equivalent to muscles in the animal body.

It appears that the leaves of the drosera rotundifolia and longifolia remain completely expanded during the hottest sunshine and driest weather; during the coldest and wettest weather; during the greatest darkness, and, finally, during the brightest light of day. This, however, is to be taken in a limited sense, i. e. only during the expansion of the leaves, not during the cold of winter. "Here, then, neither heat, cold, dryness, dampness, darkness, nor light in general, at all affect the leaves; but, if a foreign body be applied to the leaf so as to stimulate, then it will shut up" in the manner we have already described. See *Vegetable* ANATOMY, SUPPLEMENT.

EXPLANATION OF PLATES DXLI. DXLII. AND DXLIII.

[*Note, that some errors in the references to figures in the text may be corrected by this explanation, which is accurate.*]

Fig. 1. Part of a branch, shewing the manner in which the line of life, *c c*, enters into the flower-bud, *a*, and passes by the leaf, *b b*.

Fig. 2. A flower-bud, showing the line of life, *c c*, running up to each flower, *a, a, a, a, a, a, a*, and the pith terminating at *b*.

Fig. 3. Section of the stem of a tree; *a*, the rind; *b*, the bark; *c*, the inner bark; *d*, the wood; *e*, the spiral nerves; *f*, the corona or line of life; *g*, the pith; *h, h*, the silver grain; *o, o, o*, the bastard grain.

Fig. 4. Cylinders of the inner bark.

Fig. 5. Cylinders of the wood.

Fig. 6, 7, 8, 9. Commencement of the growth of leaves, exhibited in different stages. *a, a, a, a*, The mid-rib; *b, b, b*, the young vessels appearing like cotton; *c, c*, the spiral nerves; *d*, the smaller vessels crossing each other. Fig. 9. also shews, *e, e*, the fine vessels growing up each side of the mid-rib; and *f*, the pabulum.

Fig. 10. Leaf-bud of the lime-tree.

Fig. 11. Leaf-bud of the horse-chesnut about January.

Fig. 12. A seed-vessel of the class syngenesia; *a*, the calyx; *b*, female florets; *c*, male and female florets.

Fig. 13. Section just above the seed-vessel of the dianthus. *a*, the calyx proceeding from the bark; *b*, the the corolla, from the inner bark; *c, c, c, c*, ten stamina from the wood; *d*, the seed-vessel; *e*, the pistil from the corona or circle of life.

Fig. 14. Representation of the bean. *o, o*, the nourishing vessels; L to *n*, the seminal leaves, or cotyledons; *l*, to *l*, the embryo.

Fig. 15. *o*, The nourishing vessels; *l l*, the embryo in the seed of the lily, crossing the empty part of the corculum.

Fig. 16. Shews, *l, l*, the line of life; *o, o*, the nourishing vessels.

Fig. 17. Represents the heart taken out of the seed of a chesnut. *l*, the circular hook; *o, o*, the nourishing vessels; *l, l*, the line of life, which was taken out where it crosses the heart at *m*.

Fig. 18. The seed of the gooseberry. *o*, the nourishing vessels; *l*, the line of life; *m*, the corculum or heart.

Fig. 19. The sting of the nettle, as viewed with the solar microscope; *z*, the bag of poison; *x*, the spiral wire.

Fig. 20. The sting after the poison has been thrown to the point; *x*, the spiral wire contracted.

Fig. 21. Indian grass greatly magnified, showing the manner in which it is formed.

Fig. 22. Awn of the grass.

Fig. 23 and 24. The grass twisted.

Fig. 25. Leaf of the mimosa sensitiva.

Fig. 26. A longitudinal section of the leaf-stalk of the mimosa sensitiva, the middle part containing five cases of spiral wire, and each extremity only three.

Fig.

Fig. 27. The extremity of the uncut leaf-stalk, which is divided at *p p* in fig. 26.

Fig. 28. A horizontal section of the stem of the mimosa.

Fig. 29. A case full of the spiral wire much magnified.

Fig. 30. Spiral wire still more magnified.

Fig. 31. Leaf of the mimosa pudica.

VEGETATIVE SOUL, among philosophers, denotes that principle in plants, by virtue of which they vegetate, or receive nourishment and grow.

VEHICLE, in general, denotes any thing that carries or bears another along; but is more particularly used in pharmacy for any liquid serving to dilute some medicine, in order that it may be administered more commodiously to the patient.

VEII, in *Ancient Geography*, a city of Etruria, the long and powerful rival of Rome; distant about 100 stadia, or 12 miles, to the north-west; situated on a high and steep rock. Taken after a siege of 10 years by Camillus, six years before the taking of Rome by the Gauls: and thither the Romans, after the burning of their city, had thoughts of removing; but were dissuaded from it by Camillus (Livy). It remained standing after the Punic war; and a colony was there settled, and its territory assigned to the soldiers. But after that it declined so gradually, as not to leave a single trace standing. Famous for the slaughter of the 300 Fabii on the Cremera (Ovid). The spot on which it stood lies near Isola, in St Peter's patrimony (Holstenius).

VEIL, a piece of stuff, serving to cover or hide any thing.

In the Romish churches, in time of Lent, they have veils or curtains over the altar, crucifix, images of saints, &c.

A veil of crape is worn on the head by nuns, as a badge of their profession: the novices wear white veils, but those who have made the vows black ones. See the article NUN.

VEIN, in *Anatomy*, is a vessel which carries the blood from the several parts of the body to the heart. See ANATOMY, N° 123.

VEIN, among miners, is a fissure in the horizontal strata which contains ore, spar, cauk, clay, chert, croil, brownhen, pitcher-chert, cur, which the philosophers call the *mother of metals*, and sometimes *soil of all colours*. When it bears ore, it is called a *quick vein*; when no ore, a *dead vein*.

VELA, a remarkable cape on the coast of Terra Firma, in South America. W. Long. 71. 25. N. Lat. 12. 30.

VELARIUS, in antiquity, an officer in the court of the Roman emperors, being a kind of usher, whose post was behind the curtain in the prince's apartment, as that of the chancellor's was at the entry of the ballustrade; and that of the ostiarii at the door. The velarii had a superior of the same denomination, who commanded them.

VELEZ-DE-GOMARA, a town of Africa, in the kingdom of Fez, and in the province of Eriff. It is the ancient ACARTH. With a harbour and a handsome castle, where the governor resides. It is seated between two high mountains, on the coast of the Mediterranean sea. W. Long. 4. 0. N. Lat. 35. 10.

VELITES, in the Roman army, a kind of ancient soldiery, who were armed lightly with a javelin, a cask, cuirass, and shield.

VELLEIUS PATERCULUS. See PATERCULUS.

VELLUM, is a kind of parchment, that is finer, evener, and more white than the common parchment. The word is formed from the French *velin*, of the Latin *vitulinus*, "belonging to a calf."

VELOCITY, in *Mechanics*, swiftness; that affection of motion whereby a moveable is disposed to run over a certain space in a certain time. It is also called *celerity*, and is always proportional to the space moved. See QUANTITY, N° 11 and 14, &c.

VELVET, a rich kind of stuff, all silk, covered on the outside with a close, short, fine, soft shag, the other side being a very strong close tissue.

The nap or shag, called also the *velveting*, of this stuff, is formed of part of the threads of the warp, which the workman puts on a long narrow-channelled ruler or needle, which he afterwards cuts, by drawing a sharp steel tool along the channel of the needle to the ends of the warp. The principal and best manufactories of velvet are in France and Italy, particularly in Venice, Milan, Florence, Genoa, and Lucca: there are others in Holland, set up by the French refugees; whereof that at Haerlem is the most considerable: but they all come short of the beauty of those in France, and accordingly are sold for 10 or 15 per cent. less. There are even some brought from China; but they are the worst of all.

VENAL, or VENOUS, in *Anatomy*, something that bears a relation to the veins. This word is also used for something bought with money, or procured by bribes.

VENEERING, VANEERING, or *Fineering*, a kind of marquetry, or inlaying, whereby several thin slices or leaves of fine wood, of different kinds, are applied and fastened on a ground of some common wood.

There are two kinds of inlaying: the one, which is the more ordinary, goes no farther than the making of compartiments of different woods; the other requires much more art, and represents flowers, birds, and the like figures. The first kind is what we properly call *veneering*; the latter we have already described under MARQUETRY.

The wood intended for veneering is first sawed out into slices or leaves, about a line thick: in order to saw them, the blocks or planks are placed upright in a kind of vice or sawing press: the description of which may be seen under the article just referred to. These slices are afterwards cut into slips, and fashioned divers ways, according to the design proposed; then the joints being carefully adjusted, and the pieces brought down to their proper thickness, with several planes for the purpose, they are glued down on a ground or block of dry wood, with good strong English glue. The pieces thus joined and glued, the work, if small, is put in a press; if large, it is laid on the bench, covered with a board, and pressed down with poles, or pieces of wood, one end whereof reaches to the ceiling of the room, and the other bears on the boards. When the glue is quite dry they take it out of the press and finish it; first with little planes, then with divers scrapers, some whereof resemble rasps, which take off dents, &c. left by the planes. When sufficiently scraped, the work is polished with the skin of a

Fig. 1.

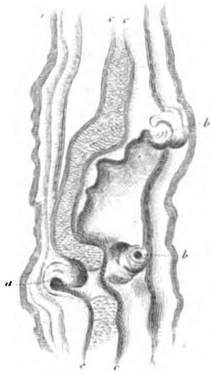

Fig. 2.

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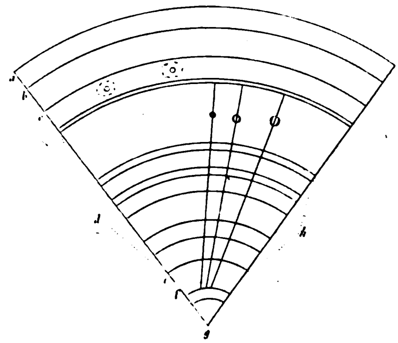

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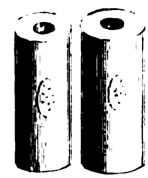

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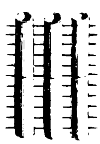

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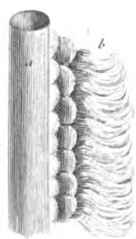

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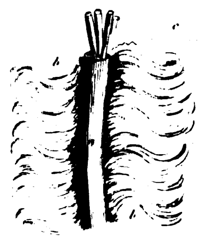

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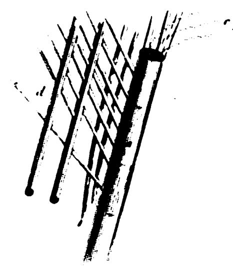

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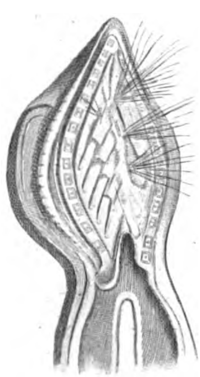

Fig. 11.

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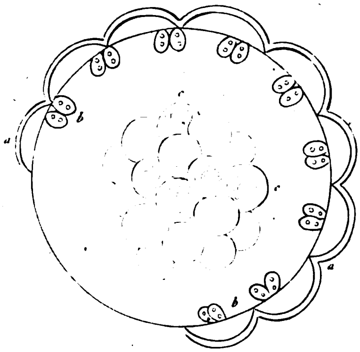
Fig. 12.



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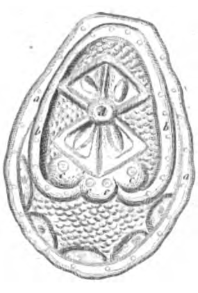

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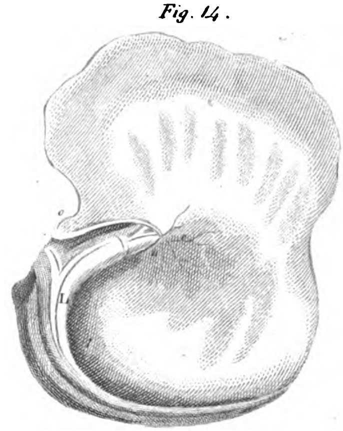

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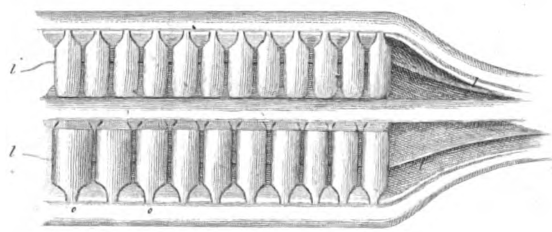

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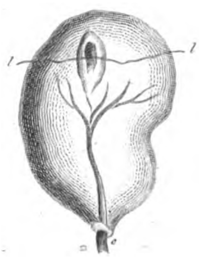

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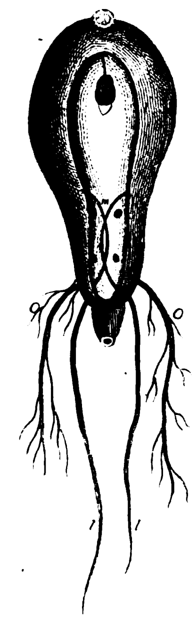

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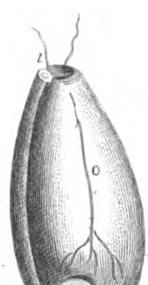

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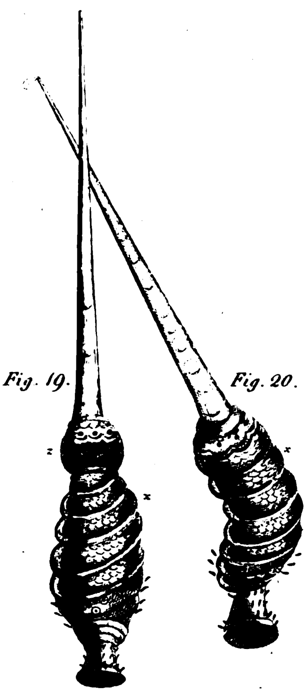

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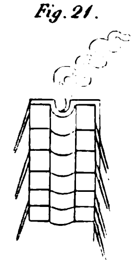

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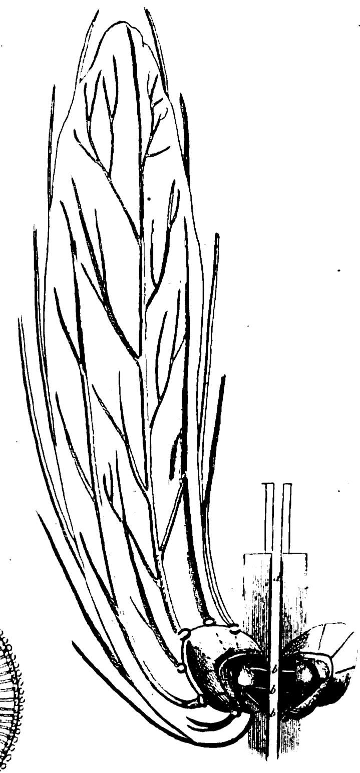
Fig. 22.

Fig. 23.

Fig. 24.

Fig. 25.



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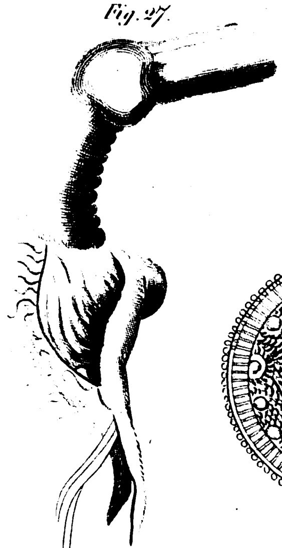

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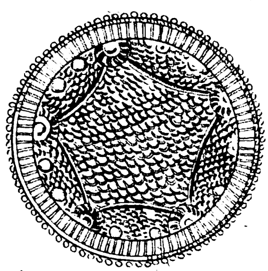

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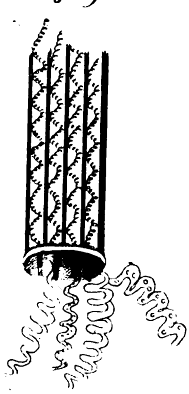

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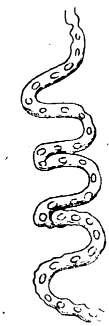

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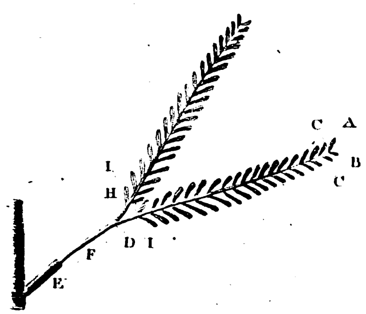

a sea dog, wax, and a brush and polisher of shave-grass: which is the last operation.

VENEREAL, something belonging to venery; as the *lues venerea*, &c. See MEDICINE *Index*.

VENERY, is commonly used for the act of copulation, or coition, between the two sexes; it has also been employed by old writers as applicable to hunting or *the chace*, as *beasts of venery*.

VENESECTION, or PHLEBOTOMY, in *Surgery*. See SURGERY *Index*.

VENETIAN BOLE, a fine red earth used in painting, and called in the colour shops *Venetian red*.—It is dug up in Carinthia, and sent from Venice to all parts of the world; but the use of it is much superseded by a bright colcothar of vitriol.

VENICE, STATE OF, formerly a celebrated republic, which for nearly ten centuries formed one of the most powerful maritime states of Europe. Its dominions lay chiefly along the coasts at the head of the Adriatic sea, comprehending not only a considerable tract round the city of Venice, but several districts both to the east and west of that sea, together with the islands of Corfu, Zante, Cephalonia, Cerigo, and some others of less note in the Archipelago. It was bounded to the north by the Alps, to the west by the duchy of Milan, and to the east by Croatia, a province of Turkey in Europe.

1 Situation and boundaries.

The republic of Venice is said to have taken its rise from a small Italian colony, who in the middle of the 5th century were driven by Attila king of the Huns from the cities of Aquileia, Verona, Mantua, &c. and took refuge in the group of small islands where now stands the city of Venice. Here they established themselves, and formed a small independent state, adopting the consular form of government which had so long prevailed at Rome. By the end of the 5th century they had become of consequence, and were able to raise and maintain a fleet and a small army. They engaged in a war with the Lombards, and distinguished themselves against the Istrian pirates, and the inhabitants of the neighbouring port of Trieste. They also assisted Justinian in his contest with the Goths, and received from him and his general Narses, many marks of favour and distinction,

2 Origen. An. 452.

About the year 697, the tribunitian power, which had prevailed in Venice from the end of the 5th century, was abolished, and the states elected a supreme magistrate, whom they called doge, or duke. He was to represent the honour and majesty of the state; to assemble and preside at the great council, where he had a casting vote in all disputed points; to nominate to all offices, places, and preferments, and to enjoy the same authority in the church as in the state. Excepting a short intermission of about five years, the power of the doges continued till the fall of the republic.

3 Establishment of a doge or duke. An. 697.

Under the doges, the power and wealth of the republic continued to increase. In 765, the Heraclians and Gezulans, subjects of the republic, revolted, and threw themselves on the protection of the emperor Charlemagne. That emperor settled them for the present at Malamoe, in the neighbourhood of the Venetian capital; but from this asylum they were quickly driven by the forces of the republic, Incensed at this affront committed against his authority, Charlemagne ordered his son Pepin to declare war against the Venetians; but as Astolphus king of the Lombards was then laying waste the territories of the church, the troops of Pepin were, by the intreaties of the pope, dispatched against that powerful monarch; and though, on the defeat of Astolphus they marched against the Venetians, it does not appear that the enterprise was productive of either honour or success. The war with Pepin was renewed in 804, on occasion of Obelerio, the doge of Venice, shewing an inclination to favour the Greek emperor Nicephorus against Pepin. Obelerio was related to the French monarch, having married his sister; and as on this account the Venetians were jealous of the attachment of their doge, he was superseded, and Valentin nominated commander in his place. Pepin had collected a numerous and well appointed army, and had fitted out a fleet to act against the Venetians by sea. With this formidable force he advanced directly to Venice, but here he was opposed with all the valour of independent citizens fighting for their liberties.

4 War with the emperor Charlemagne. An. 765.

The Venetians, however, notwithstanding the most obstinate defence, the most vigorous sallies, and their selling every inch of ground at an incredible expence of blood, were at length reduced to that part of the city south of the Rialto *(see the next article)*; this stream and their own bravery, being now their only defence. While Pepin was preparing to throw a bridge over the canal, they resolved, as a last effort, to attack Pepin's fleet, and to vanquish or die in defence of their liberty. Embarking all the troops they could spare, they bore down with the advantage of the wind and tide, upon the enemy, and began the attack with such fury, as obliged the French admiral to give way. The lightness of their ships, and the knowledge of the soundings, gave the Venetians every advantage they could wish: the enemy's fleet was run aground, and the greater part of their troops perished in attempting to escape: the ships were all to a few either taken or destroyed. During this action at sea, Pepin resolved to assault the city by land, not doubting but the garrison was so weakened by the number of forces they had sent on board the fleet, as to be able to make but a slight resistance. Having for this purpose thrown a bridge over the Rialto, he was marching his troops across it, when he found himself attacked on every side by the Venetians from their boats, and others who had posted themselves on the bridge. The battle was long, bloody, and doubtful, until the Venetians employed all their power to break down the bridge; which at last yielding to their obstinate endeavours, a prodigious slaughter of the French ensued; they fought, however, like men in despair, seeing no hopes of safety but in victory; but all communication being cut off with the troops on shore, they were to a man either killed or drowned. The number of slain was so great that the space between the Rialto and Malamoe was covered with dead bodies, and has ever since gone by a name expressive of the prodigious slaughter. Pepin was so struck with the intrepidity of the Venetians, that he raised the siege, abandoned the enterprise, and concluded a peace with the republic.

5 Intrepidity and success of the Venetians. An. 804.

In 839, the Venetians engaged in an offensive and defensive alliance against the Saracens, with the Greek emperor Michael, to whose assistance they sent a fleet of 60 galleys. In an engagement which took place between the allied fleets and that of the Saracens, the former

6 Venetian fleet defeated by the Saracens. An. 839.

Venice.

mer were completely defeated, and almost all the Venetian galleys were either taken or destroyed. On the news of this defeat, the capital was thrown into the greatest consternation, justly dreading an attack from the victorious Saracens. This alarm, however, soon subsided, on finding that the barbarians had turned off on the side of Ancona. The city now became a prey to internal dissension. Popular tumults were frequent, and in one of these the doge was murdered. By the prudent and vigorous administration of a succeeding doge, Orso Participato, good order was re-established, and at the commencement of the 10th century, the reputation of the republic for military prowess was much advanced by a victory gained over the Huns, who had invaded Italy, and defeated Berengarius.

7
Increased power of the republic.
An. 1084.

Towards the close of the 11th century, Venice began to make a considerable figure among the states of Europe, having acquired the sovereignty of Dalmatia and Croatia, with which in 1084 they were formally invested by the Constantinopolitan emperor.

8
Take an active part in the crusades.
An. 1096.

About this time a crusade, or holy war against the Saracens, was preached up by the emissaries of the pope, and the Venetian republic engaged in the undertaking with such ardour, as to equip a fleet of 200 sail, under the command of the doge Vitalis Michael. Before he sailed for the coast of Asia, however, the doge found it necessary to chastise the Pisans, whom he defeated in a terrible engagement. He then sailed for Askalon, at that time besieged by the Christian forces, and it was chiefly by his valour that that city, as well as Caipha and Tiberias, fell into the hands of the Christians. From these victories he was recalled to repel an invasion of Dalmatia by the Normans, whom he also defeated, carrying off considerable booty. His successor assisted Baldwin in the conquest of Ptolemais, but was defeated and killed in attempting to quell a rebellion of the Croatians.

9
Dispute with the Greek emperor,

Under the government of Domenico Micheli, who succeeded Ordelapho, the pope's nuncio arrived at Venice, and excited such a spirit of enthusiasm among all ranks and degrees of men, that they strove whose names should be first enrolled for the holy war. The doge, having fitted out a fleet of 60 galleys, sailed with it to Joppa, which place the Saracens were at that time besieging. The garrison was reduced to the last extremity when the Venetian fleet arrived, which surprised and defeated that of the enemy with great slaughter; soon after which the Saracens raised the siege with precipitation. Tyre was next besieged, and soon was obliged to capitulate; on which occasion, as well as on the taking of Ascalon, the Venetians shared two-thirds of the spoils. While the doge was absent on those important affairs, the emperor of Constantinople, jealous of the growing power of the Venetians, resolved to take advantage of their apparent incapacity to resist an attack at home. The Venetians, however, had timely notice of his approach, and instantly recalled the doge, who on his return laid waste and destroyed the country round Chios, seized on the islands of Samos, Lesbos, and Andros, then belonging to the emperor, and reduced several places in Dalmatia which had revolted.

10
and with Barbarossa.
An. 1173.

In 1173, the republic ventured to oppose Frederick Barbarossa in his attack on the pope. Frederick, after a haughty reply to an embassy sent him by the Venetians, dispatched against them his son Otho, who soon arrived before the city with 75 galleys. The doge Sebastiano Ziani sailed out with the few vessels he had got equipped, to give the enemy battle. The fleets met off the coast of Istria, and a terrible engagement ensued, in which the imperial fleet was totally defeated, Otho himself taken prisoner, and 48 of his ships destroyed. On the doge's return, the pope went out to meet him, and presented him with a ring, saying, "Take this, Ziani, and give it to the sea, as a testimony of your dominion over it. Let your successors annually perform the same ceremony, that posterity may know that your valour has purchased this prerogative, and subjected this element to you, even as a husband subjecteth his wife." Otho was treated with the respect due to his rank, and soon conceived a great friendship for Ziani. At last, being permitted to visit the imperial court, on his parole, he not only prevailed on his father to make peace with the Venetians, but even to visit their city, so famed for its commerce and naval power. He was received with all possible respect, and on his departure attended to Ancona by the doge, the senate, and the whole body of the nobility. During this journey he was reconciled to the pope; and both agreed to pay the highest honours to the doge and republic.

11
They gain possession of Constantinople.
An. 1204.

In the beginning of the 13th century, the Venetians in conjunction with the French, besieged and took Constantinople, as has been related under the article CONSTANTINOPOLITAN HISTORY, N° 144—146, which they held till the year 1261.

12
War with the Genoese.

In the mean time the Genoese, by their successful application to commerce, having raised themselves in such a manner as to be capable of rivalling the Venetians, a long series of wars took place between the republics; in which the Venetians generally had the advantage, though sometimes they met with terrible overthrows. These expensive and bloody quarrels undoubtedly contributed to weaken the republic notwithstanding its successes. In the year 1348, however, the Genoese were obliged to implore the protection of Visconti duke of Milan, in order to support them against their implacable enemies the Venetians. Soon after this, in the year 1352, the latter were utterly defeated with such loss, that it was thought the city itself must have fallen into the hands of the Genoese, had they known how to improve their victory. This was in a short time followed by a peace; but from this time the power of the republic began to decline. Continual war with the states of Italy, with the Hungarians, and their own rebellious subjects, kept the Venetians employed, so that they had no leisure to oppose the Turks, whose rapid advances might have alarmed all Europe. After the destruction of the eastern empire, however, in 1453 the Turks began more immediately to interfere with the republic. Whatever valour might be shewn by the Venetians, or whatever successes they might boast of, it is certain the Turks ultimately prevailed; so that for some time it seemed scarcely possible to resist them. What also contributed greatly to the decline of the republic, was the discovery of a passage to the East Indies by the Cape of Good Hope in 1497. Till then the greatest part of the East India goods imported into Europe passed through the hands of the Venetians; but as soon as the Cape was discovered, the conveyance by the way of Alexandria almost entirely ceased. Still, however, the Venetian

An. 1348.

power

Venice.

power was strong; and in the beginning of the 16th century they maintained a war against almost the whole force of France, Germany, and Italy, associated against them in what has been called the *League of Cambray*. Soon after, however, we find them entering into an alliance with the king of France against the emperor.

13 Opposed by the league of Cambray. An. 1508.

After this, nothing of importance occurs in the history of the Venetian republic till the year 1645, when the republic was involved in a new and sanguinary conflict with the Turks, in defence of the important island of Candia. The transactions to which this war gave rise, and the spirit and bravery displayed by the Venetians, in defending their colonial possessions, are amply detailed under the article CANDIA.

14 New wars with the Turks. An. 1645.

At the end of the 17th century, the Venetians obtained an important acquisition of territory by the conquest of the Morea, which at the peace of Carlowitz in 1699, was formally ceded by Turkey to the state of Venice *.

15 The Venetians conquer the Morea; An. 1687.

* See Mod. Univ. Hist. vol. xxvii.

During the war of the Succession, the states of Venice observed a strict neutrality. They considered that dispute as unconnected with their interests; taking care, however, to keep on foot an army on their frontiers in Italy, of sufficient force to make them respected by the belligerent powers. But soon after the peace of Utrecht, the Venetians were again attacked by their old enemies the Turks, who beholding the great European powers exhausted by their late efforts, and unable to assist the republic, thought this the favourable moment for recovering the Morea, which had been so lately ravished from them. The Turks obtained their object, and at the peace of Passarowitz in 1715, which terminated this unsuccessful war, the Venetian states yielded up the Morea; the grand seignior on his part restoring to them the small islands of Cerigo and Cerigetto, with some places which his troops had taken during the course of the war in Dalmatia.

16 which is soon after restored to Turkey. An. 1715.

From the peace of Passarowitz to the conclusion of the 18th century, the affairs of Venice ceased to form an interesting part of the history of Europe. Ever since the league of Cambray, the republic, weakened by its continual struggles with Turkey, had declined in power and in consequence, and was incapable of opposing a barrier to the encroachments of its more powerful neighbours. During the first war which the French republic maintained against the emperor in Italy, the states of Venice afforded a tempting object to each of the contending parties; and in May 1797, the capital was occupied by a body of French troops, who under pretence of quelling a tumult that had arisen in the city, took possession of the forts, and subverted the existing authorities. By the treaty of Campo Formio, concluded in October of the same year, the French consented that the emperor should take possession of the Venetian territory, with the islands in the Archipelago, which had been subject to the Venetian republic. At the treaty of Presburg in 1805, Austria was compelled to cede the Venetian states to the kingdom of Italy, of which these states continued to form a part till the overthrow of the French power in 1814, when they reverted to Austria.

17 The state of Venice becomes a province of Austria.

An. 1797.

It is not necessary for us to be very minute in our account of the late constitution and government of Venice. The government was strictly aristocratical, being vested in the great council or senate, in which each of the nobility had a seat. The nobility were extremely numerous, being computed at not fewer than 2000, whereas the whole population of the state did not exceed 2,500,000. Besides the great council, or *il consiglio grande*, there were four others; one composed of the doge and six counsellors, called *la signoria;* another called *il consiglio du pregodi*, consisting of about 250 of the nobility; a third united to *la signoria*, consisting of 28 assessors, or great sages, which gave audience to ambassadors; and a fourth, composed of 10 counsellors, who took cognizance of all criminal matters, and before whom even the doge himself must appear, if accused. The secret business of the state was often carried on by spies and informers; and there were in the ducal palace several statues of lions with open mouths, which formed so many receptacles for secret and anonymous information.

18 Constitution, government, &c. of the late republic.

The office and privileges of the doge of Venice have been already mentioned under the article DOGE. Of late this office was little more than nominal; and the doge was a mere state puppet, without authority and without power. His establishment, however, was splendid, and his revenue not contemptible. The mode of electing the doge deserves notice, as it was well calculated to prevent bribery, or the exertion of party influence. He was elected by a plurality of voices, and held his dignity for life. In his election they made use of gold and silver balls, which were put into a vessel, and served for balloting. Those who drew nine golden balls, first elected 40 counsellors, who drew 12 others, and elected 25 in addition. Of this number nine persons, who had drawn golden balls, chose 40 more; 11 of those, appointed in the same way, chose 41 counsellors, who finally proceeded to the election, till 25 votes or more fell upon the same person, who was then declared doge. After this election they placed the ducal cap upon his head, upon which he took possession of the doge's palace. He never uncovered his head to any person, because he did not wear the cap in his own name, but in that of the republic.

The military strength of the Venetians consisted of nearly 30,000 land forces, under the command of a capitano, who was always a foreigner of distinction; besides a considerable fleet, which they boasted could, in time of war, be increased to 60 men of war, and above 100 galleys. The ordinary revenues of the state have been computed at rather more than 1,000,000l. sterling, a considerable part of which arose from the customs, and the duty on salt made at Corfu and Chiosa.

VENICE, the city which was the seat of government of the Venetian republic, is built on 72 small islands at the head of the Adriatic or gulf of Venice, about five miles from the main land. That part of the gulf which lies between the city and the continent forms a kind of *laguna* or lake, which, at low water, is very shallow, and on the opposite side of the islands there are numerous shallows, the channels between which are marked by stakes, to direct ships in entering the port. The lagunes that lie between the islands form so many canals that intersect the city in all directions, and over these the streets communicate by not fewer than 500 bridges. The principal or *great* canal is broad, and has a serpentine course through the middle of the city, but the others are narrow and crooked. The streets are also narrow and winding, but clean and neat. The houses are built on piles, and have each a door opening to the adjacent

Venice ‖ Ventilator.

adjacent canal, and another to the street. As the narrowness of the streets but ill adapts them for walking in, the only places of resort on land are the *Rialto*, a noble bridge across the great canal, bordered with booths and shops and the great square of St Mark, or *Piazza di St Marco*, an irregular quadrangle, formed of several buildings some of which are magnificent. Of these, the *ducal palace* where the business of the state used to be transacted; the patriarchal church of St Mark; the steeple of St Mark, at a little distance from the church; the church of St Geminiano; and the *new* and *old Procuraries*, are most deserving the notice of travellers. The canals form the great medium of communication, as well as the principal scene of relaxation and amusement to the inhabitants. Here ply numerous gondolas, (see GONDOLA, and *Macgill's Travels*, vol. i.) which are rowed with admirable speed and dexterity by the gondoliers; and here are occasionally held races, or rather rowing matches. As the canals are, of necessity, the receptacles of all the filth of the city, they become, in hot weather, very offensive. The whole city is about six miles in circumference, and the inhabitants were formerly estimated at 160,000, but have been continually decreasing since it lost its independence: at present they are not supposed to exceed 100,000.

The inhabitants of Venice formerly carried on a flourishing trade in silk manufactures, gold lace, mirrors and other articles of glass, besides military stores and implements of war. At some distance from the city there is a large and commodious lazaretto, where ships coming from the Levant unload their goods, and perform quarantine from 20 to 40 days.

This celebrated city, once the seat of power, opulence and the fine arts, whose carnival revelries have been the subject of so many animated descriptions, has undergone a melancholy change. Her streets and canals no longer resound with the strains of the musician and the serenades of watchful lovers, and her gay gondolas, which were formerly occupied by fashionable groups and parties of pleasure, are now become the vehicles of trade, or serve for the accommodation of the soldier and the mechanic. The trade of the city, which had long declined, has, since the cession of the Venetian territory to Austria, been almost entirely transferred to Trieste. Venice is 72 miles E. by N. of Mantua; 115 N. E. of Florence; 140 E. of Milan; 212 N. of Rome, and 300 N. by W. of Naples. E. Long. 12° 33′. N. Lat. 45° 26′.

VENIRE FACIAS, in *Law*, is a judicial writ lying where two parties plead and come to issue, directed to the sheriff, to cause 12 men of the same neighbourhood to meet and try the same, and to say the truth upon the issue taken.

VENTER, signifies the belly; but it is also used for the children by a woman of one marriage: there is in law a first and second venter, &c. where a man hath children by several wives; and how they shall take in descents of lands.

VENTILATOR, a machine by which the noxious air of any close place, as an hospital, gaol, ship, chamber, &c. may be discharged and changed for fresh.

The noxious qualities of bad air have been long known; and no one has taken greater pains to set the mischiefs arising from foul air in a just light than Dr Hales; who has also proposed an easy and effectual remedy by the use of his ventilators; his account of which was read to the Royal Society in May 1741. In the November following M. Triewald, military architect to the king of Sweden, informed Dr Mortimer secretary to the Royal Society, that he had in the preceding spring invented a machine for the use of his majesty's men of war, in order to draw out the bad air from under their decks, the least of which exhausted 36,172 cubic feet in an hour, or at the rate of 21,732 tons in 24 hours. In 1742 he sent one of them, formed for a 60 gun ship to France; which was approved of by the Royal Academy of Sciences at Paris; and the king of France ordered all the men of war to be furnished with the like ventilators.

Plate DXLIV. fig. 1.

The ventilators invented by Dr Hales consist of a square box ABCD (fig. 1.) of any size; in the middle of one side of this box a broad partition or midriff is fixed by hinges X, and it moves up and down from A to C, by means of an iron rod ZR, fixed at a proper distance from the other end of the midriff, and passing through a small hole in the cover of the box up to R. Two boxes of this kind may be employed at once, and the two iron rods may be fixed to a lever FG (fig. 2.) Fig. 2. moving on a fixed centre O; so that by the alternate raising and pressing down of the lever FG, the midriffs are also alternately raised and depressed, whereby these double bellows are at the same time both drawing in air, and pouring it out, through apertures with valves made on the same side with, and placed both above and below the hinges of the midriffs. In order to render the midriffs light, they are made of four bars lengthwise, and as many across them breadthwise, the vacant spaces being filled up with thin pannels of fir board; and that they may move to and fro with the greater ease, and without touching the sides of the boxes, there is an iron regulator fixed upright to the middle of the end of the box AC (fig. 1.) from N to L, with a notch cut into the middle of the end of the midriff at Z; so that the midriffs, in rising and falling, suffer no other friction than what is made between the regulator and the notch. Moreover, as the midriff ZX moves with its edges only one-twentieth of an inch from the sides of the box ABCDFE, very little air will escape by the edges; and therefore, there will be no need of leathern sides as in the common bellows. The end of the box at AC is made a little circular, that it may be better adapted between A and C to the rising and falling midriff; and at the other end X of the midriff a slip of leather may be nailed over the joints if needful. The eight large valves through which the air is to pass, are placed at the hinge-end of the boxes BK (fig. 2.) as at 1, 2, 3, &c. The valve 1 opens inward to admit the air to enter, when the midriff is depressed at the other end by means of the lever FG. And at the same time the valve 3 in the lower ventilator is shut by the compressed air which passes out at the valve 4. But when that midriff is raised, the valve 1 shuts, and the air passes out at the valve 2. And it is the same with the valves 5, 6, &c. of the other box; so that the midriffs are alternately rising and falling, and two of the ventilators drawing in air, and two blowing it out; the air entering at the valves 1, 3, 6, 8, and passing out at the valves 2, 4, 5, 7. Before these last valves there is fixed to the ventilators a box QQNM (fig. 3.) as a common receptacle for all the air which comes out of these valves; Fig. 3. which

which air passes off by the trunk P, through the wall of a building. See Description of Ventilators by Stephen Hales, D. D. Lond, 1743, 8vo.; and for the method of freeing mines, ships, prisons, &c. from noxious air by means of fire-pipes, see PNEUMATICS, N° 371.

VENTRI Inspiciendo, is a writ to search a woman that saith she is with child, and thereby withholdeth lands from the next heir: the trial whereof is by a jury of women.

VENTRICLE, properly denotes any little cavity; but is more particularly used by physicians and anatomists for the stomach and certain cavities of the heart and brain.

VENTRILOQUISM, an art by which certain persons can so modify their voice, as to make it appear to the audience to proceed from any distance, and in any direction. See PHYSIOLOGY *Index*.

VENUS, in Pagan worship, the goddess of love and beauty. Cicero mentions two other deities of this name. Venus, styled *Urania* and *Celestis;* and the *Venus Pandemos* or *Popularis*, the wife of Vulcan, and the goddess of wanton and effeminate love. To the first the Pagans ascribed no attributes but such as were agreeable to the strictest chastity and virtue; and of this deity they admitted no corporeal resemblance, she being only represented by the form of a globe, ending conically. Her sacrifices were termed *nephalia*, on account of their sobriety. To her honey and wine were offered, and no animal except the heifer; and on her altars the wood of figs, vines, or mulberries, was not suffered to be burnt. The Romans dedicated a temple to this goddess, to whom they gave the name of *Verticordia;* because she turned the hearts of lewd women, and inspired them with modesty and virtue.

But the most famous of these goddesses is the wife of Vulcan; who is represented as springing from the froth raised by the genitals of Saturn, when cut off by Jupiter and thrown into the sea. As soon as she was formed, she was laid in a beautiful shell embellished with pearl, and wafted by gentle zephyrs to the isle of Cytherea, whence she sailed to Cyprus. At her landing, flowers rose beneath her feet; she was received by the Hours, who braided her hair with golden fillets; and then wafted her to heaven, where her charms appeared so attractive, that most of the gods desired her in marriage; but Vulcan, by the advice of Jupiter, gained possession by putting poppies into her nectar. As Venus was the goddess of love and pleasure, the poets have been lavish in the description of her beauties; and the painters and statuaries have endeavoured to give her the most lovely form. Sometimes she is represented clothed in purple, glittering with gems, her head crowned with roses, and drawn in an ivory car by swans, doves, or sparrows; at others she stands attended by the Graces; but in all positions, her son Cupid is her inseparable companion. She was honoured as the mother of Hymeneus, Cupid, Æneas, and the Graces, and was passionately fond of Adonis and Anchises.

This goddess was principally worshipped at Paphos and Cyprus; and the sacrifices offered to her were white goats and swine, with libations of wine, milk, and honey. Her victims were crowned with flowers, or wreaths of myrtle.

VENUS, one of the planets. See ASTRONOMY *Index*.

VENUS's Fly-trap. See *DIONÆA Muscipula*, BOTANY *Index*.

VENUS, a genus of shell-fish. See CONCHOLOGY *Index*.

VEPRECULÆ, diminutive from *vepres*, "a briar or bramble;" the name of the 31st order in Linnæus's Fragments of a Natural Method. See BOTANY *Index*.

VERA-CRUZ, a sea-port town of North America, in New Spain. This city is almost the sole channel of communication between Mexico and the mother country. It is beautifully and regularly built, and is situated in an arid plain, destitute of running water, on which the north winds have formed hills of moving sand. Near the town are considerable marshes and stagnant pools, which occasion intermittent fever among the inhabitants. The population of Vera-Cruz in 1803 amounted to 16,000. The port is not very secure; though it is the best on the Mexican coast. The trade of this town is very extensive: the exports consist of gold and silver in ingots, cochineal, sugar, flour, indigo, salted provisions, tanned hides, vanilla, soap, campeachy wood, &c. and amount annually, according to Humboldt, to 4,620,000l. sterling; while the imports, consisting of linens, woollens, cottons, paper, mercury, iron, brandy, wine, &c. amount only to 3,150,000l. W. Long. 96. 15. N. Lat. 19. 12.

VERAGUA, a province of New Spain, bounded on the east by that of Costa Rica, on the west by Panama, on the north by Darien and the gulf of Mexico, and on the south by the South sea. It is about 125 miles in length from east to west, and 60 in breadth from north to south. It is a mountainous barren country; but has plenty of gold and silver. Conception is the capital town.

VERATRUM, a genus of plants belonging to the class polygamia, and in the natural system arranged under the 10th order, *Coronariæ*. See BOTANY and MATERIA MEDICA *Index*.

VERB, in *Grammar*. See GRAMMAR, chap. iv.

VERBASCUM, a genus of plants of the class pentandria, and in the natural system arranged under the 28th order, *Luridæ*. See BOTANY *Index*.

VERBENA, a genus of plants of the class of diandria, and in the natural system arranged under the 40th order, *Personatæ*. See BOTANY *Index*.

VERD, CAPE, a promontory on the west coast of Africa, 40 miles north-west of the mouth of the river Gambia. W. Long. 17. 38. N. Lat. 14. 45.

The islands of Cape de Verd are seated in the Atlantic ocean, about 400 miles west of the Cape. They are between the 13th and 19th degree of latitude; and the principal are 10 in number, lying in a semicircle. Their names are, *St Antony*, *St Vincent*, *St Lucia*, *St Nicholas*, the *isle of Sal*, *Bona Vista*, *Mayo*, *St Jago*, *Fuego*, and *Brava*.

VERDICT, (*Vere dictum*), is the answer of the jury given to the court concerning the matter of fact, in any case civil or criminal, committed by the court to their trial and examination. See LAW, N° clxxxvi. 51. and TRIAL.

VERDIGRISE, the acetate of copper, much used by painters as a green colour. See COPPER, CHEMISTRY *Index*.

VERDITER, or VERDATER, a preparation of copper, sometimes used by painters, &c. for a blue; but

but more usually mixed with a yellow for a green colour. See COPPER, CHEMISTRY *Index*, and *COLOUR-Making*, N° 28.

VERGE (*Virgata*), in *Law*, signifies the compass of the king's court, which bounds the jurisdiction of the lord steward of the household; and which is thought to have been 12 miles round.

The term *verge* is also used for a stick or rod, whereby one is admitted tenant to a copyhold estate, by holding it in his hand, and swearing fealty to the lord of the manor.

VERGERS, certain officers of the courts of king's bench and common pleas, whose business it is to carry white wands before the judges. There are also vergers of cathedrals, who carry a rod tipped with silver before the bishop, dean, &c.

VERGIL, POLYDORE. See VIRGIL.

VERJUICE, a liquor obtained from grapes or apples, unfit for wine or cyder; and chiefly used in sauces, ragouts, &c.

VERMES, the sixth class of animals in the Linnæan system, comprehending five orders. See NATURAL HISTORY, and CONCHOLOGY and HELMINTHOLOGY *Index*.

VERMICELLI, or VERMICHELLY, a composition of flour, cheese, yolks of eggs, sugar, and saffron, reduced to a paste, and formed into long slender pieces like worms, by forcing it with a piston through a number of little holes. It was first brought from Italy; and is chiefly used in soups and pottages.

VERMICULAR, an epithet given to any thing that bears a relation or resemblance to worms.

VERMIFORMIS, in *Anatomy*, a term applied to various parts in the human body, bearing some resemblance to worms.

VERMILION, a bright and beautiful red colour, composed of quicksilver and sulphur, in great esteem among the ancients under the name of *minium*. See CHEMISTRY, N° 1701, and 1713; but what goes by the name of minium amongst us, is a preparation of lead, known also by the name of *red-lead*. See CHEMISTRY, N° 1832.

VERMIN is a general term, denoting those animals which are either directly or indirectly injurious to mankind, the inferior animals, or the fruits of the earth; as fleas, caterpillars, flies, worms, &c.

VERMIN, *Destruction of*. As we propose in this article to point out the means of destroying some of those animals that are hurtful or troublesome to man, we shall employ the term vermin, in a more extended sense, including also under it, mice, rats, moles, &c. We shall endeavour to collect the most useful observations that have been made on the means of diminishing or extirpating such animals as are obviously injurious. We cannot avoid here remarking, that although the seemingly excessive increase of one species of animals is hurtful or inconvenient to another, or to man himself, and their existence is attended with great loss and damage, by their infesting and destroying grains and other fruits of the earth destined for the food of man or those animals that are subservient to him; we are not of opinion that this excess ought to be considered merely as a useless excrescence in the great scale of being; nor are we of opinion that their numbers ought not to be reduced, because we are too short-sighted to comprehend the wise purposes for which they are called into life. We have heard such a doctrine held up, although we are inclined to suspect that it is founded on a love of singularity, or indolence, rather than proceeding from pure motives of benevolence. But we must abstain from such discussions, and occupy the limits allotted to the proper subject of consideration.

Rats and Mice.—Various methods have been proposed for the destruction of these vermin. The following preparation has been recommended as very effectual. Take of the seeds of stavesacre (*delphinium staphisagria*), or of lousewort (*pedicularis palustris*), powdered, more or less as the occasion requires, one part; of oat meal, three parts: mix them well, and make them up into a paste with honey. Lay pieces of this paste in the holes, and on the places where mice and rats frequent; and it will effectually kill or rid the places of those kind of vermin by their eating of it.

Some time ago the society for encouraging arts proposed a premium of 50l. for a preparation capable of alluring or fascinating rats so that they might be taken alive. In consequence of this, a great number of new traps, &c. were invented, and the following methods of alluring the rats to a certain place were published. One of the methods which is most easily and efficaciously practised, is the trailing of some pieces of their most favourite food, which should be of the kind which has the strongest scent, such as toasted cheese or boiled red herrings, from the holes or entrances of the closet to their recesses in every part of the house or contiguous building. At the extremities, and at different parts of the course of this trailed track, small quantities of meal, or any other kind of their food, should be laid to bring the greater number into the tracks, and to encourage them to pursue it to the place where they are intended to be taken; at that place, when time admits of it, a more plentiful repast is laid for them, and the trailing repeated for two or three nights.

Besides this trailing and way-baiting, some of the most expert of the rat-catchers have a shorter, and perhaps more effectual method of bringing them together; which is the calling them, by making such a whistling noise as resembles their own call; and by this means, with the assistance of the way-baits, they call them out of their holes, and lead them to the repast previously prepared for them at the places designed for taking them. But this is much more difficult to be practised than the art of trailing; for the learning of the exact notes or cries of any kind of beasts or birds, so as to deceive them, is a peculiar talent which is attained only by few.

In practising either of these methods of trailing or calling, great caution must be used by the operator to suppress and prevent the scent of his feet and body from being perceived; which is done by overpowering that scent, by other scents of a stronger nature. In order to do this, the feet are to be covered with cloths rubbed over with asafœtida, or other strong smelling substances; and even oil of rhodium is sometimes used for this purpose, but sparingly, on account of its high price, though it has a very alluring as well as disgusting effect. If this caution of avoiding the scent of the operators feet, near the track, and in the place where the rats are proposed to be collected, be not properly observed, it will very much obstruct the success of the attempt

Vermin. tempt to take them; for they are very shy of coming where the scent of human feet lies very fresh, as it intimates to their sagacious instinct the presence of human creatures, whom they naturally dread. To the abovementioned means of alluring by trailing, way-baiting and calling, is added another of very material efficacy, which is the use of oil of rhodium, which, like the *marum syriacum* and *valerian* in the case of cats, has a very extraordinary fascinating power on these animals. This oil, as it is extremely dear, is therefore sparingly used. It is exalted in a small quantity in the place, and at the entrance of it, where the rats are intended to be taken, particularly at the time when they are to be last brought together, in order to their destruction: and it is used also by smearing it on the surface of some of the implements used in taking by the method below described; and the effect it has in taking off their caution and dread, by the delight they appear to have in it, is very extraordinary.

It is usual, likewise, for the operator to disguise his figure as well as scent, which is done by putting a sort of gown or cloak, of one colour, that hides the natural form, and makes him appear like a post, or some such inanimate thing, which habit must likewise be scented as above, to overpower the smell of his person; and besides this, he is to avoid all motion till he has secured his point of having all the rats in his power.

When the rats are thus enticed and collected, where time is afforded, and the whole in any house and outbuildings are to be cleared away, they are suffered to regale on what they most like, which is ready prepared for them, and then to go away quietly for two or three nights; by which means those that are not allured the first night, are brought afterwards, either by their fellows, or the effects of the trailing, &c. and will not fail to come duly again, if they are not disturbed or molested. But many of the rat-catchers make shorter work, and content themselves with what can be brought together in one night; but this is never effectual, unless where the building is small and entire, and the rats but few in number.

The means of taking them when brought together are various. Some entice them into a very large bag, the mouth of which is sufficiently capacious to cover nearly the whole floor of the place where they are collected; which is done by smearing some vessel, placed in the middle of the bag, with oil of rhodium, and laying in the bag baits of food. This bag, which before lay flat on the ground with the mouth spread open, is to be suddenly closed when the rats are all in. Others drive or frighten them, by slight noises or motions into a bag of a long form, the mouth of which, after all the rats are come in, is drawn up to the opening of the place by which they entered, all other ways of retreat being secured. Others, again, intoxicate or poison them, by mixing with the repast prepared for them, the *coculus indicus*, or the *nux vomica*. They direct four ounces of *coculus indicus*, with 12 ounces of oat-meal, and two ounces of treacle or honey, made into a moist paste with strong beer; but if the *nux vomica* be used, a much less proportion will serve than is here given of the *coculus*. Any similar composition of these drugs, with that kind of food the rats are most fond of, and which has a strong flavour to bide that of the drugs, will equally answer the end. If indeed *coculus indicus* be well powdered, and infused in strong beer for some time, at least half the quantity here directed will serve as well as the quantity before mentioned. When the rats appear to be thoroughly intoxicated with the coculus, or sick with the nux vomica, they may be taken with the hand and put into a bag or cage, the door of the place being first shut, lest those who have strength and sense remaining should escape.

In destroying rats, advantage may be taken of that remarkable degree of instinct which they possess of deserting one place, where they find themselves disturbed or harassed, and retiring to new haunts. It is well known, that after one or two rats are poisoned, or taken in traps, or wounded or otherwise injured, and afterwards permitted to escape, the whole colony immediately disappears. The practice, however, of destroying rats that frequent dwelling-houses, by poison, should be as much as possible avoided; for they retire to places behind the wainscot, &c. from which, after death, their putrid bodies emitting a most offensive smell cannot be removed. But it is far less difficult than is generally imagined to secure the different apartments of a dwelling house, and even the cellars, from the inroads of rats and mice, and thus to prevent their unwelcome visits, by shutting up the passages through which they enter. Stone and lime, when they can be applied, are effectual; but common plaster, by introducing pieces of broken pottery ware or glass, along with it, will also answer the purpose; and even a piece of cork, with a pin or two stuck through it to prevent them from eating it away, is a complete barrier to mice entering through a hole in wood, and may even prevent the entrance of rats.

We have seen this method of shutting up the holes, as soon as they were opened by the industry of the enemy, steadily pursued for some time, attended with the fullest success, even in an old house of considerable extent, and finished from top to bottom with wood, some of which was much decayed.

Often for the sake of food, rats and mice frequent gardens, fields, and woods, in the summer season; but, on the approach of winter, they return to their former haunts in the habitations of man; and, accordingly, it is observed, that houses which are free from those vermin during the summer, swarm with them about the end of harvest. Attention to this circumstance in the habits of these animals, may be the means of securing us from their visits and depredations: for if, at the time alluded to, every hole and cranny through which rat or mouse can enter, be shut up, and carefully kept close and secure, the perseverance of the foe is exhausted and overcome by repeated and constant resistance, and thus he is forced to abandon the unequal contest, and to retire to other haunts where his motions are less interrupted.

Various other methods have been proposed for the destruction of rats; and although we have thrown out a hint against the use of arsenic for this purpose, in dwelling-houses; yet where it can be employed with perfect safety, and without risk of the nuisance alluded to, as in cellars and outhouses, it is undoubtedly one of the most effectual to which we can have recourse.

Suffocating these vermin by means of the fumes of sulphur, as on board of ships, in granaries, and other buildings, which can be shut up, is sometimes also successfully.

Vermin. cessfully practised. Rats and other vermin have also been effectually destroyed and eradicated by burning wood in close apartments, thus producing fixed air or carbonic acid gas, by which they are also suffocated.

Moles.—Various methods have been proposed for the destruction of these animals. But the following observations on this subject, which we shall give in the words of the author, seem to be more satisfactory than any thing we have met with.

"The great damage (says he) which moles occasion in cultivated land, and particularly gardens, is well known; and the best means of remedying this evil is by destroying all those that make their appearance, as far as possible. The secrets which quacks sell for extirpating these destructive animals are of very little avail; and even poison produces no effect, as the mole does not drink, and lives only on roots and worms. In regard to gins and traps, the moles must be enticed to them by some kind of bait, which does not always produce the intended effect. Buffon advises a trench to be dug around the hills under which they conceal themselves, and thus to cut them off from all communication with the neighbouring ground. This method requires three or four people to dig trenches; and though it may prove effectual, it is attended with too much trouble. The other methods proposed by different naturalists are neither easier nor more certain.

"It is well known that this animal lives under the earth; and if at any time it comes forth from its holes, it is only when compelled to do so, in consequence of large quantities of water accumulated after the heavy rains which fall in summer, or when the earth is so much parched and dried by the continued drought, that it can no longer continue its labour: but it again creeps back into the earth when it finds a spot convenient for its purpose.

"This animal, as already remarked, feeds upon roots and worms, and for this reason is generally found in rich fertile soil; but never in that which is marshy or stony. In the winter time it retires to elevated places, because it is there best secured from inundations. In summer, however, it descends to the low hillocks and flat land, and above all makes choice of meadows for the place of its residence, because it finds the earth there fresher and softer for it to dig through. If the weather continues long dry, it repairs to the borders of ditches, the banks of rivers and streams, and to places contiguous to hedges.

"The mole breeds generally at the beginning of winter, and the months when they are found big with young are January and February. In the month of April a great many of their young may be seen. Among 122 caught in the month of May by my method, there were only four big with young. This animal cannot live without digging; it is obliged to find its nourishment in the bowels of the earth; and on that account is under the necessity of making those long subterranean passages which are found between one mole-hill and another. In general it begins to dig five or six inches under the surface; it scrapes the earth before it on one side till the quantity becomes too great for it to labour with ease; it then works towards the surface; and by pushing with its head, and the assistance of its nervous paws, gradually raises up the earth which incommodes it, and which produces those small hills so common in fields. After getting rid of the earth in this manner, it proceeds forwards, and continues its labour as before. The farther it goes the more hills are produced. At each period of its labour it throws up four or five.

"In places overgrown with grass and shrubs, the mole is often contented with only forcing a passage through between the roots: and when the earth in gardens has been newly watered, it keeps itself at the depth of scarcely half an inch under the surface. This animal shews an equal aversion to great cold and violent heat; and in order to avoid both, it forces its way, when either prevail, to the greatest depth in the earth.

"It continues its labour at all times, because it is necessary for it to procure nourishment. It is absolutely false that it sleeps throughout the winter, as some naturalists have asserted; for it throws up the earth in the coldest season, as well as during the summer. It is most busily employed towards the end of winter, and at that period forms the greatest number of hills. To this it is impelled by more than one reason. In the first place, it must provide nourishment for its young; secondly, it finds it easiest at that time to dig its way through the earth; and lastly, as the air begins to be milder, the animal then recovers that strength which it had lost during the intense cold. At this season, therefore, it is most proper to pursue means for extirpating this animal, as it can be destroyed with greater ease while employed at its labour.

"The male is much stronger than the female, and the hills thrown up by the former are much larger as well as more numerous. The periods when the mole is most busily employed in digging are in the morning, at sunrise, at noon, and at sunset. In dry weather moles are observed to throw up the earth for the most part only at sunrise, and in winter when the earth has been somewhat heated by the sun's rays.

"A person may easily discover how many moles are contained in a certain space of ground, by counting the fresh raised mole-hills which have no communication with each other. I must remark also, that this animal has very bad sight, being almost totally blind; but its hearing, on the other hand, is so much the more acute.

"I shall now proceed to the method of destroying them. Immediately at day-break it will be necessary to make a tour round the garden or meadow, from which it is wished to extirpate the moles; for at that time they will be all found at work, as may be seen by the hills newly thrown up. If the person is then close to the hill, he must proceed as the gardeners do, and turn up with a stroke of the spade the hill together with the digger. The passage is then cut through before the animal is aware of the attack, and therefore it has not power to escape. If the mole-hill be fresh, even though the animal may not be throwing up earth, the person ought not to lose his time in waiting, but should immediately proceed to the operation above mentioned.

"If you find a fresh hill standing by itself, which seems to shew by its situation that it has no communication with any other, which is always the case when the mole has worked from the surface downwards in endeavouring to procure a more convenient habitation, after the hill has been turned up with the spade, a bucket of water should be poured over the mouth of the passage. By these means the animal, which is at no great distance, will be obliged to come forth, and may be easily caught with the hand.

"You

"You may discover also whether a hill has any communication with another, if you apply your ear to it, and then cough or make a loud noise. If it has no communication with the neighbouring hills, you will hear the terrified animal make a noise by its motion. It will then be impossible for it to escape; and you may either pour water into the hole, or turn up the hill with a spade until the mole is found; for in general it never goes deeper into the earth than from fifteen to eighteen inches.

"When any of the beds in a garden have been newly watered, the mole, attracted by the coolness and moisture, readily repairs thither, and takes up its residence in them, making a passage at the depth of scarcely an inch below the surface. In that case it may be easily caught. When you see it at work, you need only tread behind the animal with your feet on the passage to prevent its retreat, and then turn up the hill with a spade; by which means you will be sure to catch it.

"When you dig after it with a spade, the animal forces its way downwards into the earth in a perpendicular direction, in order that it may better escape the threatened danger. In that case it will not be necessary to dig long, but to pour water over the place, which will soon make the animal return upwards.

"People in general are not aware of the great mischief occasioned in fields and gardens by these animals. We are, however, informed by Buffon, that in the year 1740 he planted 15 or 16 acres of land with acorns, and that the greater part of them were in a little time carried away by the moles to their subterranean retreats. In many of these there were found half a bushel, and in others a bushel. Buffon, after this circumstance, caused a great number of iron traps to be constructed, by which in less than three weeks he caught 1300. To this instance of the devastation occasioned by these animals, we may add the following: In the year 1742 they were so numerous in some parts of Holland, that one farmer alone caught between five and six thousand of them. The destruction occasioned by these animals is, however, no new phenomenon. We are informed by history, that the inhabitants of the island of Tenedos, the Trojans, and the Æolians, were infested by them in the earliest ages. For this reason a temple was erected to Apollo Smynthius, the destroyer of moles.

Insects.—Many insects, in the different states of existence through which they pass, are exceedingly troublesome and destructive. Sometimes they spread their devastations in the state of *larva* or *grub*, and sometimes in that of perfect insect.

Of the coleopterous insects, the grub of the cockchaffer, which is a brownish or chesnut-colured beetle, commits the greatest ravages. This beetle appears during great part of the summer, the most plentiful in May or June, and hence called the *May bug*. It flies only in the evening, and lodges during the day under the leaves of trees, which it devours, and is sometimes in such numbers, as to defoliate whole woods. The beetle deposits its eggs in the earth, and from these are hatched white or bluish grubs, that feed on the roots of grass, corn, and other vegetables, during the whole summer. In the winter they lie deep in the earth; but in the spring, as vegetation advances, they rise to the surface, and renew their work of destruction. In this state they continue for four, five, or six years, before they change to the chrysalis state, in which they remain till the month of May, when the perfect insect appears. As these insects require so many years to assume the perfect form, they only appear occasionally sufficiently numerous to be extensively destructive to the crops of grain, or vegetables in general. Their numbers, however, have often produced great alarm, and even excited the attention of governments to offer rewards for an effectual method of destroying them.

In the spring season, if the weather prove warm, when the land is ploughed up, these grubs are generally so near the surface as to be turned up with the plough; and being thus exposed, they are picked up and devoured by various birds, which, it is suggested, should not be disturbed or driven away in this salutary labour. When these grubs infest meadow land, it has been proposed to drown them in their holes by overflowing it. But it is supposed that this plan would not be successful, even where it is practicable, unless there is a bed of clay immediately under the soil, to retain the water for a sufficient length of time. A more efficacious way is recommended to prevent the increase of the grubs, by destroying the flies in May or June, before they have deposited their eggs. This may be done by shaking and beating the trees and hedges in the middle of the day; and, as this is a work which may be performed by children, it is a less difficult task than would at first sight be imagined. Domestic fowls are remarkably fond of these beetles, so that a double object is thus gained, the destruction of the beetles and the procuring of food for the poultry.

Some species of the dermestes, and also of the genus *ptinus*, are exceedingly destructive in the cabinets of naturalists, and also to furniture. Various methods have been recommended to stop their ravages. We believe the most effectual is spirit of turpentine, when it can be properly applied. A solution of corrosive sublimate is sometimes employed, but it should be recollected that it seldom fails in time to produce some chemical change on animal and vegetable matters. Objects of natural history, as birds, animals, &c. are sometimes exposed to the moderate heat of an oven, or before a fire, for several hours; but this method will also be attended with injurious effects, unless practised with great care. Insects which infest furniture have been destroyed by the application of oil, and allowing it to remain for a day or two, before the furniture is rubbed up. Japanned or varnished furniture may be secured from the effects of these insects, by re-coating it, when they are in the larva state, by which they are deprived of air. Railing, and other works out of doors, which are exposed to the weather, are sometimes eaten with insects, and particularly by some of the larvæ of the genus *curculio*. The wood thus attacked may be prevented from farther ravages, by a fresh coat of paint.

The earwig is a destructive insect in the flower, kitchen, and fruit garden. To prevent their depredations, it has been recommended to take them by the hand, when they come out during the night in search of food. They may be taken also by rolling up a piece of paper, and hanging it up on the plants which they infest; for in these places they take shelter through the day. Another method of destroying them has been mentioned, and that is to watch them towards morning with the view of discovering the haunts to which

they

Vermin.

they resort during the day; and this discovery being made, which may perhaps be a melon frame, dunghill, or heap of rubbish, the removing of which will destroy the greater number of those troublesome insects.

The small insect which commits such depredations among turnips, by eating the seedling leaves as soon as they appear, as frequently to destroy whole crops, is supposed to be a small black polished beetle, belonging to the genus *chrysomela*. It does not seem to be well ascertained whether this small beetle, which is better known by the name of turnip fly, commits its ravages in the larva or in the beetle state. It is said that it prefers the leaves of the common radish to those of the turnip, and it is therefore recommended to sow radishes along with the turnips to prevent the destruction of the latter.

Of the insects belonging to the order hemiptera, there are some which are exceedingly destructive. The cock-roach, a native of the warmer parts of America and the West Indies, is a very troublesome, and a very voracious insect. It has been introduced into this country, and particularly into the seaport towns, in consequence of commercial intercourse. It comes out to feed in the night-time, and eats of almost every thing that comes in its way. Cock-roaches are easily taken by the following method. Cover the outside of a deep glass or bason with paper; introduce some bits of bread or sugar into the bason or glass, and set it in a place frequented by the cock-roaches. They creep up by means of the paper on the outside, and drop into the vessel; but in consequence of its smooth polished surface, they cannot effect their escape. In the same way crickets and beetles may be taken and destroyed. It is quite unnecessary to speak of the means of destroying the myriads of locusts which not unfrequently infest eastern countries, and particularly Egypt and Syria; for no means are likely to be devised, which promise to resist the effects of such an host of foes, by whose ravages every green thing is consumed; but the insect itself becomes, among the poorer inhabitants of those countries, a partial substitute for the fruits of the earth which it has destroyed. The insects are taken, reduced to powder, and converted into a kind of meal.

The common or the bed-bug is a very troublesome, and a very common inmate in the crowded houses of many large towns in this country. Its usual haunts are the crevices of wood, and particularly those pieces of furniture which are usually kept in the warmest corners of the apartment. Cleanliness will perhaps be found the best preservative against the introduction and increase of these insects; but sometimes even the greatest care and attention are ineffectual in keeping houses entirely free from them. When it can be conveniently done, they are completely destroyed by immersing the furniture in boiling water, or by baking it in an oven; and by filling up the crevices or holes which were their haunts, with glaziers putty, their return and increase will thus be prevented. But a very effectual method of destroying bugs, is to wash the places which they frequent with spirit of turpentine, and then filling up the holes as already mentioned. It is a curious circumstance in the history of these insects, that some persons entirely escape from their attacks, while to others they are exceedingly troublesome and distressing. It is said that lavender-water, sprinkled over the bed-clothes, often prevents their approach. How far this is the case, we have had no opportunity of ascertaining.

Vermin.

The small moth, which in the caterpillar state commits such ravages on woollen cloths, furs, and other animal substances, which remain for any length of time in dark undisturbed places, may be destroyed with the greatest certainty and facility, by exposing the substances on which they are suspected to make their depredations, to the vapour of spirit of turpentine, or brushing them with a brush dipped into the same fluid. This should be done about the months of September or October; but their effects may be prevented by placing the cloths, furs, &c. which are likely to become their residence, in an airy situation, about the months of July and August.

The different kinds of lice are very numerous. Every animal has its peculiar species, and even mankind are not free from this pest. It is often the consequence of indolence and nastiness, and it is observed that the lice which infest any animal increase prodigiously when that animal becomes languid and sickly. We believe that the application of spirits of turpentine, already so often recommended, would also be effectual in this case; but mercurial preparations afford a certain remedy against these insects. For this purpose a very small quantity of what is called mercurial ointment may be employed. At the same time it ought to be recollected, that cleanliness is the best preservative. A singular notion prevails in this country, and even among persons who are by no means in the lowest rank of life, that it is a good sign of health when children's heads are infested with these animals; and on this account they are not very anxious in having them entirely eradicated. A moment's reflection may show the absurdity of such an opinion, so that it would be a waste of time to adduce serious arguments against it.

It is perhaps more difficult for mankind to secure themselves and their habitations from the visits of the common flea. Cleanliness, however, may do much even in effecting this; and in particular it appears to us, that it would be extremely useful, frequently to rub up with a piece of cloth the more inaccessible parts of furniture or apartments, or perhaps it would answer better to employ a small hard brush. By the less accessible places we mean the corners and crevices of rooms and furniture where dust is apt to collect, and especially the canvas part of a bed. We are persuaded that spirits of turpentine might also be found useful for the destruction of these very troublesome insects. The Scotch myrtle (*myrica gale*, Lin.) a plant very common in low and moist moorish places in this country, is said to be an excellent remedy, in consequence of its powerful aromatic odour, against the attacks of these animals. For this purpose, the plant is strewed about the apartment or bed which is infested with fleas.

The following method of destroying or driving away all kinds of noxious vermin from fields and gardens, it is said, has been proved by experience to be effectual. It is recommended by M. Socoloff, and the account of it is taken from the Petersburgh Transactions *. "As the destructive power of quicklime (says the author), heightened by a fixed alkali, which corrodes, dissolves and destroys all the tender parts of animals, has been long known, I thought this mixture would be the best means for accomplishing the object I had in view. I took three

* Phil. Mag. i. 169.

Vermin. three parts, therefore, of quicklime, newly made, and two parts of a saturated solution of fixed alkali in water, and thence obtained a somewhat milky liquor sufficiently caustic, highly hostile and poisonous to earthworms and other small animals; for as soon as it touched any part of their bodies, it occasioned in them violent symptoms of great uneasiness. If this liquor be poured into those holes in which the earthworms reside under ground, they immediately throw themselves out as if driven by some force; and, after various contortions, either languish or die. If the leaves of plants or fruit-trees, frequented by the voracious caterpillars, which are so destructive to them, be sprinkled over with this liquor, these insects suddenly contract their bodies and drop to the ground. For, though nature has defended them tolerably well by their hairy skins from any thing that might injure their delicate bodies, yet, as soon as they touch with their feet or mouths leaves which have been moistened by this liquor, they become as it were stupefied, instantly contract themselves, and fall down.

"I had not an opportunity of trying a like experiment on locusts; yet we may conclude, and not without probability, from their nature, and the general destructive qualities of the above liquor, that they, in like manner, may be driven from corn-fields, if it be possible to sprinkle the corn with the liquor by means of a machine.

"With regard to plants or corn, these sustain no injury from the liquor, because it has no power over the productions of the vegetable kingdom, as I have fully learned from experience; or, if any hurt be suspected, all the danger will be removed by the first shower that falls. This liquor may be procured in abundance in every place where lime is burnt. If the lime be fresh, one part of it infused in about seventy parts of common water will produce real lime-water. The want of the fixed alkali may be supplied by boiling wood-ashes in water, and thickening the ley by evaporation.

"The liquor might be employed also to kill bugs and other domestic insects which are noxious and troublesome; but on account of its strong lixivious smell, which disposes the human body to putridity, I dare not recommend the use of it in houses that are inhabited. Besides, bugs may be easily got rid of, as I have repeatedly found from experience, by the oily pickle that remains in casks in which salted herrings have been packed. To this liquor they have a strong aversion; and, if they are moistened with it, they die in a very short time *."

* Phil. Mag. i. 169.

For destroying insects and caterpillars, which infest fruit-trees, the following method is recommended as having been successfully practised. The author observes that "The present year, for instance, (1805), offers a singularity which I have not before perceived. In some districts the cherry tree has experienced, at the time of its blossoming, colds and winds which have prevented it from setting; but another plague, not less disastrous has attacked the cherry-trees and plum-trees over several districts in France. Great swarms of little animals resembling *vine-fretters*, but which are not so in reality, established their habitations at the extremity of the branches of the cherry-trees. As soon as a branch was attacked, the leaves curled, and the juice was dried up. On opening the leaf, a considerable number of ants was discovered, which, jointly with the insect which began the ravages, sucked the branch, and made it wither. What I have remarked is, that usually, when the vine-fretters attack any tree, the neighbouring tree very soon experiences the same fate; but the attack of this year is only partial. In an alley of cherry-trees which I possess, seven trees have been attacked, but not those which are next each other. One tree was placed between two which were very much damaged by these insects, and yet this one was not hurt.

"On these vermin the smoke of tobacco had no effect at all; this convinces me that they are different from the ordinary kind.

"Plum-trees, when attacked by the same insect, do not lose their fruit like the cherry-trees; but the little animals cover them with more rapidity, so as to extirpate even the appearance of fruit.

"Having effectually watered a plum-tree, I covered it with ashes, in the manner we treat beans and cabbages, and the vermin were destroyed: but this is only practicable with a tree of low height.

"I made one remark, which I think is essential to communicate: it is, that plum-trees planted in ground which is not necessarily watered, are less attacked by these insects than those which have experienced a humidity communicated by the plants in their neighbourhood, to which watering is absolutely necessary. I had one planted in a bed of artichokes: we know very well that this plant requires plenty of water; and the tree was entirely covered with insects. Its leaves withered, and the fruit fell off; while two other plum-trees, in ground not watered at all, were much less attacked. This convinces me that these were not the ordinary vermin abundant in dry seasons.

"I was only able to protect my cherries a little, by cutting off the extremities of the damaged branches.

"Several people had recourse to sulphur; but I did not follow that method. The smoke of sulphur destroys the insect, I admit, but it is at least equally dangerous to the tree; I always prefer an aspersion of the tree with soap-suds. This very year I experienced the good effects of it. I saw my plum-trees look green again, and the insects abandon them. The aspersion is very easily managed, by means of watering-pots or small garden-engines. I have also employed a ley of wood-ashes with the same success as soap and water.

"An observation equally important which I have made is, the great damage done this season in all orchards by the caterpillar. As soon as they devoured the young leaves, they attacked the fruit. In spite of the great care taken in spring to get rid of them, the number of these insects is incredible. I have seen them unite on the large branches, fix their nests to them, and protect them by means of the downy matter which covers the buds of the ensuing season. Whatever precaution is taken, it is almost impossible not to destroy these buds. It is only necessary to take off these nests and burn them; and this is the only way of getting rid of the coveys. I employed the same aspersion for my apple-trees, and by that means got rid of their enemies also *.

* Phil. Mag. xxiv. 213.

"The following methods are practised in Germany for freeing granaries from mites or weevils:

"1. Cover completely the walls and rafters, above and below, of the granaries which are infested by weevils, with quicklime slaked in water in which trefoil, Vermin.

wormwood, and hyssop have been boiled. This composition ought to be applied as hot as possible.

The following method, discovered by M. Catin, is proposed for destroying earth-fleas, bugs, ants, &c.

"Take black soap, of the best kind, one pound three quarters, the same quantity of flowers of sulphur, mushrooms two pounds, and sixty measures of river or rain-water. Divide the water into two parts, one of which must be poured into a vessel destined for that purpose: suffer the soap to dissolve in it, and add the mushrooms after they have been a little pounded. Boil the other half of the water in a kettle, and tie up the sulphur in a bit of rag or piece of fine linen, and suspend from it a sufficient weight in order that it may sink in the water. During the time the water is kept boiling, which must be at least 20 minutes, stir it continually with a stick, and press the bag containing the sulphur, that the latter may be forced out into the water, and communicate to it the necessary strength and colour.

"When the liquor is taken from the fire, pour it directly into the cask, and stir it round for a considerable time: the process of stirring must be repeated daily till it acquire a fetid smell. Experience has shown that the more fetid the mixture is, its activity is the greater. Each time that the mixture is stirred, the cask must be stopped immediately after. When you wish to use the liquid, nothing is necessary but to sprinkle a little of it on the plants which you are desirous of preserving, or to dip their branches in it. It will be better, however, to make use of a syringe, having at the end a head, an inch or an inch and a half in diameter, pierced with small holes. This instrument may be used for tender plants; when you apply the liquid to trees, a syringe with larger holes must be employed.

"Caterpillars, beetles, earth-fleas, bugs, and the tree-lice which infest orange trees, will be destroyed by the first application of the liquid. Insects which reside below the earth, such as wasps, hornets, ants, &c. require that the liquid should be squirted out gently, and without intermission, that it may better penetrate to their nests. Ants nests, according to their size, require from two to three measures of liquid, and in many cases it must be applied for twenty-four hours. When the ants assemble in another place, the process must be repeated. Two ounces of *nux vomica* may be added to the mixture, and boiled along with the sulphur."

The use of elder as a preservative to vegetables against the depredations of insects is detailed in the following observations.

"Common elder has appeared to me useful, 1st, For preventing cabbage plants from being devoured or damaged by caterpillars; 2d, To prevent blights, and their effects on fruit and other trees; 3d, To preserve corn from yellow flies and other insects; 4th, To secure turnips from the ravage of flies, &c.

"1st, The strong and fetid odour of a bunch of elder leaves induced me to think that different kinds of butterflies might be incommoded by it in proportion to their delicacy. I therefore took some young twigs of elder, at the period when butterflies began to appear, and whipped well with them some cabbage plants, but in such a manner as not to damage them. Since that time, during two summers, though the butterflies hovered round the plants, I never saw one of them settle on them; and I do not think that a single butterfly was hatched on the cabbages treated in this manner, though a neighbouring board was dirtied by them in the usual manner.

"2d, After a short reflection on the effects here mentioned, and on blights, which, in my opinion, are chiefly occasioned by small flies and small insects, whose organs are still more delicate than those of the former, I was induced to whip in the same manner with elder twigs, as high as I could reach, the branches of a plum-tree which grew in an espalier. The whipped leaves remained green and in a good condition, while from at least six inches above to the top of the tree the rest of the leaves were blighted, wrinkled, and full of worms. It is here to be observed that the tree was in full flower when I whipped it, therefore much too late for this operation, which ought to have been performed once or twice before flowering. But I am of opinion, that if trees were besprinkled with a strong infusion of elder every eight or 15 days, the success would be certain, and that there would be no danger of injuring either the flowers or the fruit.

3d, What the farmers call the yellows in corn, and which they consider as a kind of blight, is the effect, as every one knows, of a small yellow fly with blue wings, nearly of the size of a gnat. It lays its eggs in the ear of wheat, and produces a worm almost invisible to the naked eye, but which, when seen by a magnifying glass, is a large yellow larva, having the shining colour of amber. This fly is so productive, that I have counted upwards of forty worms in the chaff of one ear of wheat, which was a number sufficient to destroy it entirely. I therefore proposed to make my experiment as soon as possible; but the heat and drought of the season having advanced the wheat more than usual, it was in flower before I could attempt it. Next morning, however, at break of day, two servants having drawn bundles of elder over the ears of wheat on each side of the furrow, backwards and forwards, in places where the wheat was not so far advanced, I hoped that the fetid effluvia of the elder would prevent the flies from remaining on the ears that were covered with them: and, indeed, I was not entirely disappointed; for, on examining my wheat some time after, I found that the part which had been beaten with elder was much less damaged than that which had not been treated in the same manner. I have no doubt, that, had I employed this precaution sooner, the corn would have been completely preserved. Should this be the case, the process is simple; and I flatter myself that fine crops of corn may be saved by these means from this small insect, which is so destructive to them. One of these yellow flies laid on my thumb at least eight or ten eggs, of an oblong form, in the small interval of time which I employed in walking over two or three furrows, holding it by the wings, and which I could not observe without the assistance of a magnifying glass.

"4th, It often happens that whole crops of turnips are destroyed while young, in consequence of being pricked by certain insects. I have great reason to think that this evil may be prevented in an effectual manner, by causing a person to draw a bunch of elder, sufficiently large to cover about the breadth of a foot, over the young turnips, going backwards and forwards. What confirms me in this idea is, that, having drawn a bunch of elder over a bed of young cauliflowers which had begun to be pricked, they afterwards remained untouched by these insects.

"Another

"Another fact which tends to support this idea is that when my neighbourhood, about eight or nine years ago, was so infested with caterpillars that they devoured all the vegetables, leaving scarcely a green leaf untouched, they spared the elder trees amidst this general devastation, and never molested them. In reflecting on these circumstances, I am of opinion that the elder might be introduced with advantage in our gardens, as the means of preserving fruit-trees and various plants from the rapacity of insects.

"The dwarf elder appears to me to exhale a much more fetid smell than the common elder, and therefore ought to be preferred in making experiments on this subject *."

* *Phil. Mag.* xv. 63.

VERMONT, one of the states of the North American republic. It is entirely an inland state, and has New Hampshire on the east, Massachusetts on the south, New York on the west, and Canada on the north. Its area is 10,237 square miles; and the inhabitants in 1810 amounted to 217,895. The country is traversed by the Green mountains, from which the state takes its name; but though hilly and uneven, it is generally fertile. The whole surface in its natural state is thickly wooded. The snow lies from the middle of December to the middle of March. The extreme summer heat is about 94° F.; the extreme winter cold 27° below zero; the mean heat $43\frac{1}{7}$. Lake Champlain forms the western boundary of this state for three fourths of its length, and Connecticut river the eastern boundary through its whole extent. There are several small streams besides these, but no other considerable rivers in the state.

There are rich mines of iron in Vermont, and mines of lead and copper of less importance. Marble and slate are also found in it. Its natural forests furnish timber of large size, and a great variety of kinds. Of quadrupeds, there are the bear, wolf, wild cat, fox, ermine, racoon, beaver and musk rat. The lakes and rivers furnish a great variety of fish.

The inhabitants have a more florid complexion than those of the middle and southern states. They are temperate and industrious, and with a few exceptions are engaged in agriculture.

The legislature consists of a general assembly chosen annually by ballot, by the male taxable citizens of twenty-one years of age; and the executive power is vested in a governor, lieutenant-governor, and twelve counsellors chosen along with the representatives. A peculiar feature in the constitution, is the council of censors, thirteen in number, chosen every seven years by the people, to examine and report upon the proceedings of the executive and the representatives, and with power to call a convention of the people to amend the constitution. The judges are chosen annually by the council and assembly. A portion of land out of each township is set apart for the support of the clergyman of any denomination that is first settled. The prevailing sect are the Congregationalists, the next in number the Baptists. Tracts of land have been set apart also for the support of schools. There are two colleges, at Burlington and Middlebury.

The value of houses and lands in this state in 1799 was 16,723,873 dollars, and in 1814 it was 32,747,290, and the average value of lands at the latter period was 6 dollars 40 cents per acre. The manufactures of this state in 1810 were valued at 4,325,824 dollars; and the exports in 1817 amounted to 913,201 dollars.

VERNACULAR, a word applied to something that is peculiar to any one country.

VERNAL, something belonging to the spring-season.

VERNIER SCALE, a scale excellently adapted for the graduation of mathematical instruments, thus called from its inventor Peter Vernier, a person of distinction in the Franche Comté. See NONIUS.

Vernier's method is derived from the following principle. If two equal right lines, or circular arcs, A, B, are so divided, that the number of equal divisions in B is one less than the number of equal divisions of A, then will the excess of one division of B above one division of A be compounded of the ratios of one of A to A, and of one of B to B.

For let A contain 11 parts, then one of A to A is as 1 to 11, or $\frac{1}{11}$. Let B contain 10 parts, then one of B to B is as 1 to 10, or $\frac{1}{10}$. Now $\frac{1}{10}-\frac{1}{11}=\frac{11-10}{10\times 11}=\frac{1}{10\times 11}=\frac{1}{10}\times\frac{1}{11}$.

Or if B contains n parts, and A contains $n+1$ parts; then $\frac{1}{n}$ is one part of B, and $\frac{1}{n+1}$ is one part of A. And $\frac{1}{n}-\frac{1}{n+1}=\frac{\overline{n+1}-n}{n\times\overline{n+1}}=\frac{1}{n}\times\frac{1}{n+1}$

The most commodious divisions, and their aliquot parts, into which the degrees on the circular limb of an instrument may be supposed to be divided, depend on the radius of that instrument.

Let R be the radius of a circle in inches; and a degree to be divided into n parts, each being $\frac{1}{p}$th part of an inch.

Now the circumference of a circle, in parts of its diameter 2R inches, is $3,1415926\times 2R :: 1^\circ : \frac{3,1415926}{360}\times 2R$ inches.

Or, $0,01745329\times R$ is the length of one degree in inches.

Or, $0,01745329\times R\times p$ is the length of 1°, in pth parts of an inch.

But as every degree contains n times such parts, therefore $n=0,01745329\times R\times p$.

The most commodious perceptible division is $\frac{1}{8}$ or $\frac{1}{10}$ of an inch.

Example. Suppose an instrument of 30 inches radius, into how many convenient parts may each degree be divided? how many of these parts are to go to the breadth of the vernier, and to what parts of a degree may an observation be made by that instrument?

Now $0,01745\times R=0,5236$ inches, the length of each degree: and if p be supposed about $\frac{1}{8}$ of an inch for one division; then $0,5236\times p=4,188$ shows the number of such parts in a degree. But as this number must be an integer, let it be 4, each being 15″; and let the breadth of the vernier contain 31 of those parts, or $7\frac{1}{4}°$, and be divided into 30 parts.

Here $n=\frac{1}{4}$; $m=\frac{1}{30}$; then $\frac{1}{4}\times\frac{1}{30}=\frac{1}{120}$ of a degree, or 30′, which is the least part of a degree that instrument can show.

If $n=\frac{1}{5}$, and $m=\frac{1}{36}$; then $\frac{1}{5}\times\frac{1}{36}=\frac{60}{5\times 36}$ of a minute, or 20″.

The following table, taken as examples in the instruments commonly made from 3 inches to 8 feet radius, shows the divisions of the limb to nearest tenths of inches, so as to be an aliquot of 60's, and what parts of a degree may be estimated by the vernier, it being divided into such equal parts, and containing such degrees as their columns show.

Rad. inches.	Parts of a degree.	Parts in vernier.	Breadth of vernier	Parts observed.	
3	1	15	$15\frac{1}{4}$	4′	0″
6	1	20	$20\frac{1}{4}$	3	0
9	2	20	$10\frac{1}{4}$	1	30
12	2	24	$12\frac{3}{4}$	1	15
15	3	20	$6\frac{3}{4}$	1	0
18	3	30	$10\frac{1}{4}$	0	40
21	4	30	$7\frac{1}{4}$	0	30
24	4	36	$9\frac{3}{4}$	0	25
30	5	30	$7\frac{1}{8}$	0	20
36	6	30	$5\frac{1}{4}$	0	20
42	8	30	$3\frac{7}{8}$	0	15
48	9	40	$4\frac{5}{9}$	0	10
60	10	36	$3\frac{17}{10}$	0	10
72	12	30	$2\frac{7}{12}$	0	10
84	15	40	$2\frac{2}{3}$	0	6
96	15	60	4	0	4

By altering the number of divisions, either in the degrees or in the vernier, or in both, an angle can be observed to a different degree of accuracy. Thus, to a radius of 30 inches, if a degree be divided into 12 parts, each being five minutes, and the breadth of the vernier be 21 such parts, or $1\frac{3}{4}^{\circ}$, and divided into 20 parts, then $\frac{1}{12}\times\frac{1}{20}=\frac{1^{\circ}}{240}=15''$: or taking the breadth of the vernier $2\frac{7}{12}^{\circ}$, and divided into 30 parts; then $\frac{1}{12}\times\frac{1}{30}=\frac{1^{\circ}}{360}$, or $10''$: Or $\frac{1}{12}\times\frac{1}{50}=\frac{1^{\circ}}{600}=6''$; where the breadth of the vernier is $4\frac{1}{4}^{\circ}$.

VERONA, a city of Italy, capital of the Veronese, and in the territory of Venice, now subject to Austria; situated on the river Adige, in E. Long. 11. 24. N. Lat. 45. 26. It is seven miles in compass; and is strongly fortified. It contains 57,400 inhabitants.

VERONESE, a district of Italy, in the Austro-Venetian territories; bounded on the north by the Trentino, on the east by the Vicentino and Paduano, on the south by the Mantuano, and on the west by the Bresciano. It is about 35 miles in length, and 27 in breadth; and fertile in corn, wine, fruits, and cattle.

VERONESE. See CAGLIARI.

VERONICA, a genus of plants of the class of diandria; and in the natural system arranged under the 40th order, *Personatæ*. See BOTANY *Index*.

VERSAILLES, a town of France, in the department of Seine and Oise, 10 miles west-south-west of Paris. It contained 26,000 inhabitants in 1817, and since the Revolution has been created a bishop's see. In the reign of Louis XIII. it was only a small village. This prince built here a hunting-hut in 1630, which Bassompierre calls "the paltry chateau of Versailles." Although the situation was low and very unfavourable, Louis XIV. built a magnificent palace here, which was the usual residence of the kings of France till the 6th of October 1789, when the late unfortunate Louis XVI. and his family were removed from it to the Thuilleries. The buildings and the gardens are adorned with a vast number of statues, done by the greatest masters, and the water-works are all worthy of admiration. The great gallery is thought to be as curious a piece of workmanship of that kind as any in the world: nor is the chapel less to be admired for its fine architecture and ornaments. The gardens, with the park, are five miles in circumference, and surrounded by walls. There are three fine avenues to Versailles; one of which is the common road to Paris, the other comes from Seaux, and the third from St Cloud. E. Long. 2. 12. N. Lat. 48. 48.

VERSE, in *Poetry*, a line consisting of a number of long and short syllables, which run with an agreeable cadence.

VERSE is also used for a part of a chapter, section, &c.

VERSIFICATION, the art or manner of making verse; also the tune and cadence of a verse. See POETRY, Part III.

VERSION, a translation of some book or writing out of one language into another. See TRANSLATION.

VERT, in *Heraldry*, the term for a green colour. It is called *vert* in the blazon of the coats of all under the degree of nobles: but in coats of nobility it is called *emerald;* and in those of kings *venus*. In engraving it is expressed by diagonals, or lines drawn athwart from right to left, from the dexter chief corner to the sinister base.

VERTEBRÆ. See ANATOMY, N° 30.

VERTEX, in *Anatomy*, denotes the crown of the head. Hence vertex is also used figuratively for the top of other things: thus we say, the vertex of a cone, pyramid, &c.

VERTEX, is also used in *Astronomy* for the point of the heaven directly over our heads, properly called the *zenith*.

VERTICILLATÆ, the name of a class in Ray's and Boerhaave's Methods, consisting of herbaceous vegetables. It is also the name of the 42d order in Linnæus's Fragments of a Natural Method.

VERTICILLUS, a mode of flowering, in which the flowers are produced in rings at each joint of the stem, with very short foot-stalks. The term is exemplified in mint, horehound, and the other plants of the natural order described above.

VERTICITY, is that property of the loadstone whereby it turns or directs itself to one particular point.

VERTIGO, in *Medicine*. See there, N° 82.

VERTUMNUS, in *Mythology*, a god who presided over gardens and orchards, honoured among the Etruscans, from whom the worship of this deity was transmitted to the Romans.

Vertumnus had a temple near the market-place at Rome, being represented as one of the tutelar deities of the merchants. The commentators on Ovid say, that

that he was an ancient king of Hetruria, who, by his diligent and successful cultivation of fruit and gardens, obtained the honour of being ranked among the gods.

VERUMONTANUM, in *Anatomy*, a small eminence near the passages where the semen is discharged into the urethra.

VERVAIN. See VERBENA, BOTANY *Index*.

VERTOT D'AUBOEF, *Rene Aubert de*, a celebrated historian, who descended from a noble and ancient family in Normandy, and born in 1655. At 16 years of age he became a Franciscan friar; afterwards he entered into the order of the Premonstratenses, in which he had several benefices: and at length was a secular ecclesiastic. He became secretary to the duchess of Orleans, member of the Academy of Inscriptions, and historiographer of Malta. He died at Paris in 1735. His principal works are, 1. The History of the Revolutions of Sweden. 2. The Revolutions of Portugal. 3. The Revolutions of the Romans. 4. The History of Malta. These works are written in elegant French, and translated into most of the languages of Europe.

VERULAM. See BACON.

VESALIUS, ANDREAS, a celebrated physician and anatomist, was born at Brussels about the year 1512. He studied physic at Paris under James Sylvius; but applied himself chiefly to anatomy, which was then very little known, dissections being esteemed unlawful and impious: and it appears from his work *De Humani Corporis Fabrica*, that he perfected himself in this useful knowledge very early. About the year 1537, the republic of Venice made him professor in the university of Padua, where he taught anatomy for seven years; Charles V. called him to be his physician, as he was also to Philip II. king of Spain. Vesalius was now at the height of his glory, when all of a sudden he formed the design of taking a journey to Palestine; concerning which journey we are told the following story. A young Spanish nobleman he attended, being believed to be dead, Vesalius obtained leave to open him to explore the true cause of his illness; but when he opened the breast, he perceived symptoms of life, and saw the heart beat. The parents, not satisfied with prosecuting him for murder, accused him of impiety to the inquisition, in hopes that tribunal would punish him with greater rigour: but the king interposing, saved him on condition of his making a pilgrimage to the Holy Land. He was shipwrecked on his return, and thrown upon the island of Zante, where he perished, in 1564. He was the author of several works, the principal of which is *De Humani Corporis Fabrica*.

VESICATORIUM, a BLISTER; an application of an acrid nature made to any part of the body, in order to draw a flux of humours to that part, and thus elevate the scarfskin into a blister.

VESPA, the WASP; a genus of insects belonging to the order of hymenoptera. See ENTOMOLOGY *Index*.

VESPASIAN, the 10th emperor of Rome; remarkable for his clemency and other virtues. See ROME, N° 332—339.

VESPERS, in the church of Rome, denote the afternoon service; answering in some measure to the evening prayers of the church of England.

VESPERTILIO, the BAT; a genus of quadrupeds, belonging to the order of primates. See MAMMALIA *Index*.

VESSEL, a general name given to the different sorts of ships which are navigated on the ocean, or in canals and rivers. It is, however, more particularly applied to those of the smaller kind, furnished with one or two masts. See SHIP.

VESTA, in pagan worship, the same with Cybele. See CYBELE.

VESTA the *Younger*, in pagan worship, the goddess of fire, was the daughter of Saturn and Cybele, and the sister of Ceres. She was so much in love with chastity, that on Jupiter's ascending the throne and offering to grant whatever she asked, she only desired the preservation of her virginity, which she obtained.—Vesta was not represented in her temple by any image.

VESTA, one of the lately discovered planets, of which the elements have been determined by Dr Gauss in a communication to the Royal Society of Gottingen.

Elements of Vesta.

Epoch of the longitude, meridian of Seeberg	108°	19′	34.7″
Diurnal tropical motion			770″ 85′ 84
Annual	78	9	23
Aphelion, 1806	326	37	59
Annual motion	+	2	1.2
Ascending node, 1806	80	53	23
Annual motion	+		1.5
Inclination of the orbit, 1806	10	37	34
Annual diminution			0.4
Eccentricity, 1806	0.0783486		
Annual diminution	0.0000058		
Log. of the greater semiaxis	0.4420728		

Elements of Ceres by the same.

Epoch of the mean longitude at Bremen, March 29, 1807, at 12 o'clock, mean time	193°	8′	4.6″ *
Longitude of its perihelion	249	7	41
———— aphelion	69	57	52
———— ascending node on the ecliptic	103	8	36
Inclination of its orbit	7	5	49.5 †
Diurnal tropical motion	0	16	18.91
Logarithm of the mean distance	0.3728428		
Eccentricity	0.097505		
Greatest distance from the sun	25.625		
Least	21.514		
Period of its revolution	1321 days, 12 hours.		

* In the Mag. Encyclop. it is 192° 9′ 54″.

† Ibid. 7° 8′ 34″.

VESTALIA, in Roman antiquity, a festival celebrated in honour of the goddess Vesta, on the 5th of the ides of June; that is, on the 9th of the month.

VESTALS, among the ancient Romans, were priestesses of the goddess Vesta, and had the perpetual fire committed to their charge; they were at first only four in number, but afterwards increased to six; and it does not appear that their number ever exceeded six, among whom was one superior to the rest, and called *vestalis maxima*.

The vestals were chosen from six to ten years of age, and obliged to strict continency for 30 years; the first 10 of which were employed in learning the ceremonies of religion, the next 10 in the performance of them, and the 10 last in teaching them to the younger vestals.

The

The habit of the vestals consisted of a head-dress, called *infula*, which sat close to the head, and from whence hung certain laces called *vitta;* a kind of surplice made of white linen, and over it a purple mantle with a long train to it.

VESTIBLE, or VESTIBULE, in *Architecture*, a kind of entrance into a large building; being an open place before the hall, or at the bottom of the staircase.

VESTRY, a place adjoining to a church, where the vestments of the minister are kept; and also a meeting at such place, consisting of the minister, church-wardens, and chief men of most parishes, who make a parish vestry or meeting. By custom there are select vestries, being a certain number of persons chosen to have the government of the parish, make rates, and take the accounts of church-wardens, &c.

VESUVIAN, a mineral substance. See MINERALOGY *Index*.

VESUVIUS, a celebrated volcano of Italy, six miles east from the city of Naples. This mountain has two tops; one of which only goes by the name of *Vesuvius*, the other being now called *Somma;* but Sir William Hamilton is of opinion, that the latter is what the ancients called *Vesuvius*.

1
General description of the mountain.

The perpendicular height of Vesuvius is only 3700 feet, though the ascent from the foot to the top is three Italian miles. One side of the mountain is well cultivated and fertile, producing great plenty of vines; but the south and west sides are entirely covered with cinders and ashes; while a sulphureous smoke constantly issues from the top, sometimes attended with the most violent explosions of stones, the emission of great streams of lava, and all the other attendants of a most formidable volcano. The first of these eruptions recorded in history took place in the year 79; at which time the two cities of Pompeii and Herculaneum were entirely buried under the stones and ashes thrown out. Incredible mischief was also done to the neighbouring country, and numbers of people lost their lives, among whom was Pliny the Elder.

2
Account of the first eruption recorded in history.

It is the opinion of the best judges, however, that this eruption was by no means the first that had ever happened. The very streets of those cities which were at that time overwhelmed are said to be partly paved with lava. Since that time 30 different eruptions have been recorded, some of which have been extremely violent. In the year 1538, a mountain, three miles in circumference, and a quarter of a mile in perpendicular height, was thrown up in the course of one night.

3
Of the eruption in 1767.

The first great eruption taken notice of by Sir William Hamilton was that of 1767, which, though very violent, was mild in comparison with that of 1538.

4
Nine eruptions from 1767 to 1779.

From this time (1767) Vesuvius never ceased for ten years to send forth smoke, nor were there many months in which it did not throw out stones, scoriæ, and cinders; which, increasing to a certain degree, were usually followed by lava; so that from the year 1767 to 1779 there were nine eruptions, some of them very considerable. In the month of August that year, however, an eruption took place, which, for its extraordinary and terrible appearance, may be reckoned among the most remarkable of any recorded concerning this or any other volcano.

5
Account of the great eruption in 1779.

During the whole month of July the mountain continued in a state of fermentation. Subterraneous explosions and rumbling noises were heard; quantities of smoke were thrown up with great violence, sometimes with red-hot stones, scoriæ, and ashes; and towards the end of the month these symptoms increased to such a degree as to exhibit, in the night-time, the most beautiful fireworks that can be imagined.

On Thursday 5th August the volcano appeared most violently agitated; a white and sulphureous smoke issued continually and impetuously from its crater, one puff seeming to impel another; so that a mass of them was soon accumulated, to appearance four times the height and size of the volcano itself. These clouds of smoke were exceedingly white, so that the whole resembled an immense accumulation of bales of the whitest cotton. In the midst of this very white smoke, vast quantities of stones, scoriæ, and ashes, were thrown up to the height of 2000 feet; and a quantity of liquid lava, seemingly very heavy, was lifted up just high enough to clear the rim of the crater, and take its way down the sides of the mountain. This lava, having run violently for some hours, suddenly ceased, just before it had reached the cultivated parts of the mountain, near four miles from the spot whence it issued. The heat, all this day, was intolerable at the towns of Somma and Ottaiano; and was sensibly felt at Palma and Lauri, which are much farther off. Reddish ashes fell so thick on the two former, that the air was darkened, and that objects could not be distinguished at the distance of ten feet. Long filaments of a vitrified matter, like spun glass, were mixed, and fell with these ashes; several birds in cages were suffocated, and the leaves of the trees in the neighbourhood of Somma were covered with white and very corrosive salt.

6
Extraordinary effusion of fire by the approach of stormy clouds.

About 12 at night, on the 7th, the fermentation of the mountain seemed greatly to increase. Our author was watching the motions of the volcano from the mole at Naples, which has a full view of it. Several glorious picturesque effects had been observed from the reflection of the deep red fire within the crater of Vesuvius, and which mounted high amongst those huge clouds on the top of it: when a summer storm, called in that country a *tropea*, came on suddenly, and blended its heavy watery clouds with the sulphureous and mineral ones, which were already like so many other mountains piled up on the top of the volcano. At this moment a fountain of fire was shot up to an incredible height, casting so bright a light, that the smallest objects were clearly distinguishable at any place within six miles or more of Vesuvius. The black stormy clouds, passing swiftly over, and at times covering the whole or a part of the bright column of fire, at other times clearing away and giving a full view of it, with the various tints produced by its reverberated light on the white clouds above in contrast with the pale flashes of forked lightning that attended the tropea, formed such a scene as no power of art can express. One of his Sicilian majesty's gamekeepers, who was out in the fields near Ottaiano whilst this storm was at its height, was surprised to find the drops of rain scald his face and hands; a phenomenon probably occasioned by the clouds having acquired a great degree of heat in passing through the above-mentioned column of fire.

On the 8th, the mountain was quiet till towards six o'clock in the evening, when a great smoke began to gather over its crater; and about an hour after a rumbling

Vesuvius.

bling subterraneous noise was heard in the neighbourhood of the volcano; the usual throws of red-hot stones and scoriæ began and increased every instant. The crater, viewed through a telescope, seemed much enlarged by the violence of last night's explosions, and the little mountain on the top was entirely gone. About nine o'clock a most violent report was heard at Portici and its neighbourhood, which shook the houses to such a degree as made the inhabitants run out into the streets. Many windows were broken, and walls cracked by the concussion of the air on this occasion, though the noise was but faintly heard at Naples. In an instant a fountain of liquid transparent fire began to rise, and gradually increasing, arrived at last at the amazing height of ten thousand feet and upwards. Puffs of smoke, as black as can possibly be imagined, succeeded one another hastily, and accompanied the red-hot, transparent, and liquid lava, interrupting its splendid brightness here and there by patches of the darkest hue. Within these puffs of smoke, at the very moment of emission, a bright but pale electrical fire was observed playing briskly about in zig-zag lines. The wind was south-west, and, though gentle, was sufficient to carry these puffs of smoke out of the column of fire; and a collection of them by degrees formed a black and extensive curtain behind it; in other parts of the sky it was perfectly clear, and the stars bright. The fiery fountain, of such immense magnitude, on the dark ground just mentioned, made the finest contrast imaginable; and the blaze of it reflected from the surface of the sea, which was at that time perfectly smooth, added greatly to this sublime view.

7 Immense fountain of lava thrown up by Vesuvius.

The lava, mixed with stones and scoriæ, having risen to the amazing height already mentioned, was partly directed by the wind towards Ottaiano, and partly falling, still red hot and liquid, upon the top of Vesuvius, covered its whole cone, part of that of the summit of Somma, and the valley between them. The falling matter, being nearly as inflamed and vivid as that which was continually issuing fresh from the crater, formed with it one complete body of fire, which could not be less than two miles and a half in breadth, and of the extraordinary height above mentioned, and cast a heat to the distance of at least six miles round. The brushwood on the mountain of Somma was soon in a blaze, and the flame of it being of a different colour from the deep red of the matter thrown out by the volcano, and from the silvery blue of the electrical fire, still added to the contrast of this most extraordinary scene.

The black cloud, increasing greatly, once bent towards Naples, and threatened the city with speedy destruction; for it was charged with electrical fire, which kept constantly darting about in bright zig-zag lines. This fire, however, rarely quitted the cloud, but usually returned to the great column of fire whence it proceeded; though once or twice it was seen to fall on the top of Somma, and set fire to some dry grass and bushes. Fortunately the wind carried back the cloud just as it reached the city, and had begun to occasion great alarm. The column of fire, however, still continued, and diffused such a strong light, that the most minute objects could be discerned at the distance of ten miles or more from the mountain. Mr Morris informed our author, that at Sorrento, which is 12 miles distant from Vesuvius, he read the title-page of a book by that volcanic light.

All this time the miserable inhabitants of Ottaiano were involved in the utmost distress and danger by the showers of stones which fell upon them, and which, had the eruption continued for a longer time, would most certainly have reduced their town to the same situation with Herculaneum and Pompeii. The mountain of Somma, at the foot of which the town of Ottaiano is situated, hides Vesuvius from the view of its inhabitants; so that till the eruption became considerable it was not visible to them. On Sunday night, when the noise increased, and the fire began to appear above the mountain of Somma, many of the inhabitants flew to the churches, and others were preparing to quit the town, when a sudden and violent report was heard; soon after which they found themselves involved in a thick cloud of smoke and ashes; a horrid crashing noise was heard in the air, and presently fell a vast shower of stones and large pieces of scoriæ, some of which were of the diameter of seven or eight feet, which must have weighed more than 1000 pounds before they were broken, as some of the fragments which Sir William Hamilton found in the streets still weighed upwards of 60 pounds. When these large vitrified masses either struck against one another in the air, or fell on the ground, they broke in many pieces, and covered a large space of ground with vivid sparks of fire, which communicated their heat to every thing that was combustible. These masses were formed of the liquid lava; the exterior parts of which were become black and porous by cooling in their fall through such a vast space; whilst the interior parts, less exposed, retained an extreme heat, and were perfectly red.

8 Distress of the inhabitants of Ottaiano.

In an instant the town and country about it was on fire in many parts, for there were several straw huts in the vineyards, which had been erected for the watchmen of the grapes; all of which were burnt. A great magazine of wood in the heart of the town was all in a blaze; and had there been much wind, the flames must have spread universally, and all the inhabitants would have been burnt in their houses; for it was impossible for them to stir out. Some, who attempted it with pillows, tables, chairs, the tops of wine casks, &c. on their heads, were either knocked down or soon driven back to their close quarters under arches and in the cellars of their houses. Many were wounded, but only two persons died of their wounds.

To add to the horror of the scene, incessant volcanic lightning was whisking about the black cloud that surrounded them, and the sulphureous smell and heat would scarcely allow them to draw their breath. In this dreadful situation they remained about 25 minutes, when the volcanic storm ceased all at once, and Vesuvius remained sullen and silent.

Some time after the eruption had ceased, the air continued greatly impregnated with electrical matter. The duke of Cottofiano told our author, that having, about half an hour after the great eruption had ceased, held a Leyden bottle, armed with a pointed wire, out at his window at Naples, it soon became considerably charged. But whilst the eruption was in force, its appearance was too alarming to allow one to think of such experiments. —He was informed also by the prince of Monte Mileto, that

9 Vast quantity of electric matter in the air.

Vesuvius. that his son, the duke of Popoli, who was at Monte Mileto the 8th of August, had been alarmed by the shower of cinders that fell there; some of which he had sent to Naples weighing two ounces; and that stones of an ounce weight had fallen upon an estate of his ten miles farther off. Monte Mileto is about 30 miles from the volcano. The abbé Cagliani also related, that his sister, a nun in a convent at Manfredonia, had written to inquire after him, imagining that Naples must have been destroyed, when they, at so great a distance, had been alarmed by a shower of ashes which fell on the city at 11 o'clock at night, so much as to open all the churches, and go to prayers. As the great eruption happened at nine o'clock, these ashes must have travelled 100 miles in the space of two hours.

10 Damage done by the eruption at Ottaiano.

Nothing could be more dismal than the appearance of Ottaiano after this eruption. The houses were unroofed, half buried under the black scoriæ and ashes; all the windows towards the mountain were broken, and some of the houses themselves burnt; the streets choked up with ashes, in some narrow places not less than four feet thick; and a few of the inhabitants who had just returned, were employed in clearing them away, and piling them up in hillocks, to get at their ruined houses. The palace of the prince of Ottaiano is situated on an eminence above the town, and nearer the mountain. The steps leading up to it were deeply covered with volcanic matter; the roof was totally destroyed, and the windows broken, but the house itself, being strongly built, had not suffered much.

11 Vast fragments of lava thrown out.

An incredible number of fragments of lava were thrown out during the eruption, some of which were of immense magnitude. The largest measured by Sir William Hamilton was 108 feet in circumference and 17 in height. This was thrown at least a quarter of a mile clear of the mouth of the volcano. Another, 66 feet in circumference and 19 in height, being nearly of a spherical figure, was thrown out at the same time, and lay near the former. This last had the marks of being rounded, nay almost polished, by continual rolling in torrents or on the sea-shore. Our author conjectures that it might be a spherical volcanic salt, such as that of 45 feet in circumference mentioned by M. de St Fond, in his Treatise of Extinguished Volcanoes. A third of 16 feet in height and 92 in circumference was thrown much farther, and lay in the valley between Vesuvius and the Hermitage. It appeared also, from the large fragments that surrounded this mass, that it had been much larger while in the air.

Vesuvius continued to emit smoke for a considerable time after this great eruption, so that our author was apprehensive that another would soon ensue; but from that time nothing comparable to the above has taken place. From the time of this great eruption to the year 1784 our author kept an exact diary of the operations of Vesuvius, with drawings, showing, by the quantity of smoke, the degree of fermentation within the volcano. The operations of the subterraneous fire, however, appear to be very capricious and uncertain. One day there is the appearance of a violent fermentation, and the next every thing is tranquil; but whenever there has been a considerable ejection of scoriæ and cinders, it has been a contant observation, that the lava soon made its appearance, either by boiling over the crater, or forcing its way through the crevices in the conical part of the mountain. An eruption took place in 1784, but without any remarkable circumstance, and another in 1794 which destroyed 5000 acres of cultivated land.

Vesuvius | Victor.

VETCH. See Vicia, Botany *Index*.

VETERAN, among the ancient Romans, an appellation given to a *soldier* grown old in the service, or who had made a certain number of campaigns.

VETERINARY art. See Farriery.

VEXILLUM, in *Botany*; the upper petal of a pea-bloom, or butterfly-shaped flower, which is generally larger than any of the others.

VIALES, in mythology, a name given among the Romans to the gods who had the care and guard of the roads and highways.

VIATICUM, in Roman antiquity, an appellation given in common to all officers of any of the magistrates; as *lictors*, *accensi*, *scribes*, *criers*.

VIBEX, is sometimes used by physicians, for a black and blue spot in the skin occasioned by an efflux or extravasation of blood.

VIBRATION, in *Mechanics*, a regular, reciprocal motion of a body, as a pendulum.

VIBURNUM, a genus of plants of the class pentandria; and in the natural system arranged under the 43d order, *Dumosæ*. See Botany *Index*.

VICAR, a person appointed as deputy to another, to perform his functions in his absence, and under his authority.

Vicar, in the canon-law, denotes a priest of a parish, the predial tithes whereof are impropriated or appropriated; that is, belong either to a chapter, religious house, &c. or to a layman who receives them, and only allows the vicar the small tithes, or a convenient salary. See the article *Parson and Vicar*.

VICE, in ethics, is ordinarily defined an elective habit, denoting either an excess or defect from the just medium wherein virtue is placed.

Vice, in smithery and other arts conversant in metals, a machine or instrument serving to hold fast any thing they are at work upon, whether it is to be beaten, filed, or rivetted.

Vice is also used in the composition of divers words to denote the relation of something that comes instead or in the place of another; as vice admiral, vice-chancellor, &c. are officers who take place in the absence of admirals, &c.

VICEROY, a governor of a kingdom, who commands in the name and instead of a king, with full and sovereign authority.

VICIA, a genus of plants of the class diadelphia; and in the natural system arranged under the 32d order, *Papilionaceæ*. See Botany *Index*.

VICISSITUDE, the regular succession of one thing after another; as the vicissitude of day and night, of the seasons, &c.

VICTIM, denotes a sacrifice offered to some deity, of a living creature, as a man or beast, which is slain to appease his wrath, or to obtain some favour.

VICTOR, Sextus Aurelius, a Roman historian, who flourished under the emperors Constantius and Julian; as we learn from many passages in his own writings, and also from Ammianus Marcellinus. This historian relates, that Constantius made him consul, and honoured honour him with a brazen statue, on account of his excellent qualifications; although, as he owns of himself, he was born in an obscure village, and of poor and illiterate parents. It is commonly believed that he was an African. Two books of his are extant in the historical way: one *De viris illustribus urbis Romæ;* the other, *De Cæsaribus;* to which is prefixed *Libellus de origine gentis Romanæ*. The whole makes an abridged history of Rome, from its foundation down to the reign of Julian inclusive.

VICTORY, the overthrow or defeat of an enemy in war or combat.

VICTORY, in Pagan worship, is represented by Hesiod as the daughter of Styx and Pallas; and Varro calls her the *daughter of Heaven and Earth*. The Romans erected a temple to her, where they prayed to the gods to give success to their arms. They painted her in the form of a woman, clad in cloth of gold. In some medals, she is represented with wings flying through the air, holding a laurel crown in one hand and a palm in the other; but in other medals, she is seen standing upon a globe, with the same crown and branch of palm.

VIDA, MARCUS HIERONYMUS, bishop of Alva, in Montserrat, and one of the most excellent Latin poets that have appeared since the Augustan age, was born at Cremona in 1470. Having distinguished himself by his learning and taste for literature, he was made bishop of Alva in 1552. After continuing two years with Pope Clement VII. at Rome, he went to reside upon his see; where, for 30 years, he performed all the offices of a good bishop and a good man; and though he was mild, gentle, and full of goodness, he was so far from wanting spirit, that when the city of Alva was besieged by the French, he used all possible means to prevent its being given up, by strenuously exhorting the people, and, when provisions were scarce, by supplying them at his own expence. His Poetics, and poem on the silk-worm, pass for his masterpiece; his poem on the game of chess is also greatly admired. He also wrote hymns, eclogues, and a poem entitled *Christiados* in six books; all which are in Latin, and have gained him a great reputation. His works in prose consist of dialogues, synodical constitutions, letters, and other pieces. He died in 1556, soon after being made bishop of Cremona.

VIENNA, the capital of the circle of Austria, in Germany, and of the whole German empire, is the place where the emperor resides. The city itself is not of very great extent; nor can it be enlarged, it being limited by a very strong fortification; but it is very populous. The streets, in general, are narrow, and the houses built high. Some of the public buildings are magnificent; but they appear externally to no great advantage, on account of the narrowness of the streets. The chief of them are the imperial palace, the library, and the museum; the palaces of the princes Lichtenstein, Eugene, &c. Vienna was twice ineffectually besieged by the Turks; namely, in 1589 and 1683. At the latter period, the siege was raised by John Sobieski, king of Poland, who totally defeated the Turkish army before the walls of this place. To strengthen the city against future attacks, no houses without the walls are allowed to be built nearer to the glacis than 600 yards; so that there is a circular field of that breadth all round the town, which has a very beautiful and salutary effect. These magnificent suburbs, and the town together, are said to contain above 320,000 inhabitants; yet the former are not near so populous, in proportion to their size, as the town; because many houses in the suburbs have extensive gardens belonging to them, and many families, who live during the winter within the fortifications, spend the summer in the suburbs. The cathedral is built of free-stone, is 114 yards long, and 48 broad, and the steeple is 447 feet high. The university had several thousand students, who, when this city was besieged, mounted guard. Beside this, there is the academy of Lower Austria; and the archducal library is much frequented by foreigners, as it contains above 100,000 printed books, and 10,000 manuscripts. The academy of painting is remarkable for the fine pictures it produces. The archducal treasury, and a cabinet of curiosities of the house of Austria, are great rarities. The inhabitants, in general, live in a splendid manner; and people of distinction have all sorts of wines at their tables, which they are very free with to foreigners. There is a sort of harbour on the Danube, where there are magazines of naval stores, and ships have been fitted out to serve on that river against the Turks. Vienna is an archbishop's see. It is seated at the place where the river Vienna or Wein, falls into the Danube, 30 miles west of Presburgh, 350 north-north-east of Rome, 520 south-east by south of Amsterdam, 565 east of Paris, and 680 east-south-east of London. E. Long. 16. 15. N. Lat. 48. 13.

VIENNE, a department in the west of France, forming part of the ancient Poitou. It derives its name from the river Vienne which runs through it, and falls into the Loire. There are extensive tracts of heath in this department; but the soil in other parts yields in abundance, grain, hemp, flax, fruits, and vines. Cattle, fish, game, and poultry, are plentiful. There are extensive forests and mines of coal, antimony, and iron. The manufactures, which consist of coarse woollens, linen, leather and paper, are trifling. The extent of this department is 689,883 hectares, and in 1817 it contained 253,048 inhabitants. Poitiers is the chief town.

VIENNE, *Upper*, a department of France, lying south of the Loire, on the upper branches of the river Vienne. The surface of the country is in general hilly, and the soil poor. It produces little wheat, but considerable quantities of rye and barley, and raises great numbers of cattle, horses, and mules. The hills are generally covered with wood, among which chesnuts abound. There are mines of iron, lead, copper, antimony, and coal. The manufactures consist of metals, coarse woollens and linens, handkerchiefs, pottery, &c. The extent of this department is 570,035 hectares, and the population in 1817 was 243,195. Limoges is the chief town.

VIGIL, in church history, is the eve or next day before any solemn feast; because then Christians were wont to watch, fast, and pray, in their churches.

VIGILS of Plants, a term under which botanists comprehend the precise time of the day in which the flowers of different plants open, expand, and shut.

As all plants do not flower in the same season, or month; in like manner, those which flower the same day, in the same place, do not open and shut precisely at the same hour. Some open in the morning, as the lip flowers, and compound flowers with flat spreading petals;

petals; others at noon, as the mallows; and a third set in the evening, or after sunset, as some geraniums and opuntias; the hour of shutting is equally determined. Of those which open in the morning, some shut soon after, while others remain expanded till night.

The hours of opening, like the time of flowering, seem to vary, according to the species of the plant, the temperature of the climate, and that of the season. Flowers, whose extreme delicacy would be hurt by the strong impressions of an ardent sun, do not open till night: those which require a moderate degree of heat to elevate their juices, in other words, whose juices do not rise but in the morning or evening, do not expand till then; whilst those which need a more lively heat for the same purpose, expand at noon when the sun is in his meridian strength, Hence it is, that the heat of the air being greater betwixt the tropics than elsewhere, plants which are transported from those climates into the cold or temperate climates of Europe, expand their flowers much later than in their native soil. Thus, a flower which opens in summer at six o'clock in the morning at Senegal, will not open at the same season in France and England till eight or nine, nor in Sweden till ten.

Linnæus distinguishes by the general name of *solar* (*flores solares*) all those flowers which observe a determinate time in opening and shutting. These flowers are again divided, from certain circumstances, into three species, or kinds:

Equinoctial flowers (*flores æquinoctiales*) are such as open and shut at all seasons, at a certain fixed or determinate hour.

Tropical flowers (*flores tropici*) are such whose hour of opening is not fixed at all seasons, but accelerated or retarded according as the length of the day is increased or diminished.

Meteorous flowers (*flores meteorici*) are such whose hour of expansion depends upon the dry or humid state of the air, and the greater or less pressure of the atmosphere. Of this kind is the Siberian sow-thistle, which shuts at night if the ensuing day is to be clear and serene, and opens if it is to be cloudy and rainy. In like manner the African marigold, which in dry serene weather opens at six or seven in the morning, and shuts at four o'clock in the afternoon, is a sure indication that rain will fall during the course of the day, when it continues shut after seven.

VIGO, a sea-port town of Galicia in Spain, with an old castle and a fort. It is seated in a fertile country by the sea-side. It was rendered famous by a sea-fight between the confederate fleet commanded by Sir George Rook, and a squadron of French men of war, in which the English took four galleons and five large men of war, and the Dutch five galleons and one man of war. W. Long. 8. 43. N. Lat. 42. 14.

VILLA FRANCA, the name of several towns; one in Piedmont, three miles east of Nice; another of Catalonia, 18 miles west of Barcelona; a third, the capital of St Michael, one of the Azores; and a fourth, a town of Estremadura in Spain, 57 miles south-east of Salamanca.

VILLAGE, an assemblage of houses inhabited chiefly by peasants and farmers, and having no market whereby it is distinguished from a town. The word is French, formed of *vil* or *vilis*, "low, mean, contemptible:" or rather, from the Latin *villa*, a country-house or farm.

VILLAIN, or **VILLEIN**, in our ancient customs, genotes a man of servile or base condition, viz. a bondman or servant.

VILLENAGE, in *Law*. The folk-land or estates held in villenage, was a species of tenure neither strictly feodal, Norman, or Saxon; but mixed and compounded of them all; and which also, on account of the heriots that usually attend it, may seem to have somewhat Danish in its composition. Under the Saxon government there were, as Sir William Temple speaks, a sort of people in a condition of downright servitude, used and employed in the most servile works, and belonging, both they, their children, and effects, to the lord of the soil, like the rest of the cattle or stock upon it. These seem to have been those who held what was called the *folk-land*, from which they were removeable at the lord's pleasure. On the arrival of the Normans here, it seems not improbable, that they who were strangers to any other than a feodal state, might give some sparks of enfranchisement to such wretched persons as fell to their share, by admitting them, as well as others, to the oath of fealty; which conferred a right of protection, and raised the tenant to a kind of estate superior to downright slavery, but inferior to every other condition. This they called *villenage*, and the tenants *villeins*.

These villeins, belonging principally to lords of manors, were either villeins *regardant*, that is, annexed to the manor or land: or else they were *in gross*, or at large, that is, annexed to the person of the lord, and transferable by deed from one owner to another. They could not leave their lord without his permission; but if they ran away, or were purloined from him, might be claimed and recovered by action, like beasts or other chattels. They held indeed small portions of land by way of sustaining themselves and families: but it was at the mere will of the lord, who might dispossess them whenever he pleased; and it was upon villein services, that is, to carry out dung, to hedge and ditch the lord's demesnes, and any other the meanest offices: and their services were not only base, but uncertain both as to their time and quantity.

A villein could acquire no property either in lands or goods: if he purchased either, the lord might seize them to his own use; unless he contrived to dispose of them again before the lord had seized them, for the lord had then lost his opportunity.

In many places a fine was also payable to the lord, if the villein presumed to marry his daughter to any one without leave from the lord: and by the common law, the lord might also bring an action against the husband for damages in thus purloining his property. For the children of villeins were also in the same state of bondage with their parents; whence they were called in Latin *nativi*, which gave rise to the female appellation of a villein, who was called a *neife*. In case of a marriage between a freemen and a neife, or a villein and a freewoman, the issue followed the condition of the father, being free if he was free, and a villein if he was villein, contrary to the maxim of the civil law, that *partus sequitur ventrem*. But no bastard could be born a villein, because by another maxim of our law he is *nullius filius*; and as he can *gain* nothing by inheritance, it were hard that he should *lose* his natural freedom by it. The law, however, protected the persons of villeins against atrocious injuries of the lord: for he might not kill or

Villenage. or maim his villein; though he might beat him with impunity.

Villeins might be enfranchised by manumission. In process of time they gained considerable ground on their lords; and in particular strengthened the tenure of their estates to that degree, that they came to have in them an interest in many places full as good, in others better than their lords. For the good nature and benevolence of many lords of manors having, time out of mind, permitted their villeins and their children to enjoy their possessions without interruption, in a regular course of descent, the common law, of which custom is the life, now gave them title to prescribe against their lords; and, on performance of the same services, to hold their lands in spite of any determination of the lord's will. For though in general they are still said to hold their estates at the will of the lord, yet it is such a will as is agreeable to the custom of the manor; which customs are preserved and evidenced by the rolls of the several courts-baron in which they are entered, or kept on foot by the constant immemorial usage of the several manors in which the lands lie. And as such tenants had nothing to show for their estates but those customs, and admissions in pursuance of them, entered on these rolls, or the copies of such entries witnessed by the steward, they now began to be called *tenants by copy of court roll*, and their tenure itself a *copyhold*.

Privileged VILLENAGE, a species of tenure otherwise called *villein socage*. See TENURE.

Ancient demesne consists of those lands or manors which, though now perhaps granted out to private subjects, were actually in the hands of the crown in the time of Edward the Confessor, or William the Conqueror; and so appear to have been, by the great survey in the exchequer, called the *doomsday-book*. The tenants of these lands, under the crown, were not all of the same order or degree. Some of them, as Britton testifies, continued for a long time pure and absolute villeins, dependent on the will of the lord; and common copyholders in only a few points. Others were in a great measure enfranchised by the royal favour; being only bound in respect of their lands to perform some of the better sort of villein-services, but those determinate and certain; as, to plough the king's land for so many days, to supply his court with such a quantity of provisions, and the like; all of which are now changed into pecuniary rents: and in consideration hereof they had many immunities and privileges granted to them; as to try the right of their property in a peculiar court of their own, called a *court of ancient demesne*, by a peculiar process denominated a writ of right close; not to pay toll or taxes; not to contribute to the expences of knights of the shire; not to be put on juries, and the like.

These tenants, therefore, though their tenure be absolutely copyhold, yet have an interest equivalent to a freehold: for though their services were of a base and villenous original, yet the tenants were esteemed in all other respects to be highly privileged villeins; and especially for that their services were fixed and determinate, and that they could not be compelled (like pure villeins) to relinquish those tenements at the lord's will, or to hold them against their own: *et ideo* (says Bracton) *dicuntur liberi*.

Lands holding by this tenure are therefore a species of copyhold, and as such preserved and exempted from the operation of the statute of Charles II. Yet they differ from common copyholds, principally in the privileges before mentioned: as also they differ from freeholders by one especial mark and tincture of villenage, noted by Bracton, and remaining to this day; viz. that they cannot be conveyed from man to man by the general common-law conveyances of feoffment, and the rest; but must pass by surrender to the lord or his steward, in the manner of common copyholds: yet with the difference, that, in the surrender of these lands in ancient demesne, it is not used to say, "to hold at the will of their lord," in their copies; but only, "to hold according to the custom of the manor."

Villenage ‖ St Vincent.

VILLI, among botanists, a kind of down like short hair, with which some trees abound.

VILLOSE, or VILLOUS, something abounding with villi or fibres like short hair; such is one of the coats of the stomach.

VINCA, a genus of plants of the class pentandria; and in the natural system arranged under the 30th order, *Contortæ*. See BOTANY *Index*.

St VINCENT, one of the windward Caribbee islands, which received its name from being discovered on the 22d of January, the feast of that saint. It is inhabited by a race of people, of whom Dr Robertson gives this account: "There is a great distinction in character between the Caribbees and the inhabitants of the larger islands. The former appear manifestly to be a separate race. Their language is totally different from that of their neighbours in the large islands. They themselves have a tradition that their ancestors came originally from some part of the continent, and having conquered and exterminated the ancient inhabitants, took possession of their lands and of their women. Hence they call themselves Banaree, which signifies a man come from beyond sea. Accordingly, the Caribbees still use two distinct languages, one peculiar to the men, and the other to the women. The language of the men has nothing common with that spoken in the large islands. The dialect of the women considerably resembles it. This strongly confirms the tradition which I have mentioned. The Caribbees themselves imagine that they were a colony from the Galibis, a powerful nation of Guiana in South America. But as their fierce manners approach nearer to those of the people in the northern continent, than to those of the natives of South America, and as their language has likewise some affinity to that spoken in Florida, their origin should be deduced rather from the former than from the latter. In their wars they still preserve their ancient practice of destroying all the males, and preserving the women either for servitude or for breeding."

It remained a long time after it was discovered inhabited by these people, and by another race improperly styled *Black Caribs*, who are in reality negroes descended, as is generally believed, from some who escaped out of a Guinea ship wrecked upon the coast, and gradually augmented by such as from time to time fled thither from Barbadoes. These nations were often at war; but when their quarrels were composed, they had a strength sufficient to prevent strangers from settling by force. The French, about half a century ago, at the request of the Caribs, made a descent from Martinico, and attacked the negroes, but were repulsed with loss; and found it their interest to conciliate a friendship with both nations by

St Vincent, Vinci.

by means of presents, and furnishing them with arms and ammunition.

St Vincent was long a neutral island; but at the peace of 1763, the French agreed that the right to it should be vested in the English; who, in the sequel, at the instance of some rapacious planters, engaged in an unjust war against the Caribbees, who inhabited the windward side of the island, and who were obliged to consent to a peace, by which they ceded a very large tract of valuable land to the crown. The consequence of this was that in the next war, in 1779, they greatly contributed to the reduction of this island by the French, who, however, restored it by the peace of 1783. Since that time it has continued in the possession of Great Britain. During the French revolutionary war, the Caribs revolted; and, assisted by the French, spread desolation over the whole island; but by the exertions of the governor and the British forces in the West Indies, the revolt was quelled.

St Vincent is in length about 24 miles, and about 18 in breadth. The climate is very warm. The country is in general hilly, in some places mountainous; but interspersed with a variety of pleasant valleys, and some luxuriant plains, the soil being everywhere very fertile, and the high grounds are at least in general easy of ascent. Few islands are so well watered with rivers and springs. The inhabitants raise all kinds of ground provisions in plenty. The rivers supply them with variety of fish. W. Long. 61°. N. Lat. 13°.

VINCI, Leonardo da, an illustrious Italian painter, descended from a noble Tuscan family, was born in the castle of Vinci, near Florence in 1445. He was placed under Andrea Verochia, a celebrated painter in that city; but soon surpassed him and all his predecessors so much as to be reputed the master of the third or golden age of modern painting. But his studies were far from terminating here; no man's genius was more universal: he applied himself to arts, to literature, and to the accomplishments of the body; and he excelled in every thing which he attempted. Lewis Sforza duke of Milan prevailed on him to be director of the academy for architecture he had just established; where Leonardo soon banished all the Gothic fashions, and reduced every thing to the happy simplicity of the Greek and Roman style. By the duke's order he constructed the famous aqueduct that supplies the city of Milan with water: this canal goes by the name of *Mortesana*, being above 200 miles in length, and conducts the water of the river Adda quite to the walls of the city. In 1479, he was desired to construct some new device for the entertainment of Louis XII. of France, who was then to make his entrance into Milan. Leonardo accordingly made a very curious automaton in the form of a lion, which marched out to meet the king, reared up on its hinder legs before him, and opening its breast, displayed an escutcheon with fleurs-de-lis quartered on it. The disorders of Lombardy, with the misfortunes of his patrons the Sforzi, obliging Leonardo to quit Milan, he retired to Florence, where he flourished under the Medici: here he raised the envy of Michael Angelo, who was his contemporary; and Raphael, from the study of his works, acquired his best manner of designing. At length, on the invitation of Francis I. he removed to France when above 70 years of age; where the journey and change of climate threw him into his last sickness: he languished for some months at Fontainbleau, where the king came frequently to see him; and one day rising up in his bed to acknowledge the honour done him, he fainted, and Francis supporting him, Leonardo died in his arms. His death happened in 1520. Some of his paintings are to be seen in England and other countries, but the greatest part of them are in Florence and France. He composed a great number of discourses on curious subjects; but none of them have been published but his treatise on the Art of Painting.—For his anatomical knowledge, see Anatomy (history of), p. 669.

Vinci, Virgil.

VINCULUM, in *Algebra*, a character in form of a line or stroke drawn over a factor, divisor, or dividend, when compounded of several letters or quantities, to connect them, and shows that they are to be multiplied or divided, &c. together by the other term.

Thus $d \times \overline{a+b-c}$ shows that d is to be multiplied into $a+b-c$.

VINE. See Vitis, Botany *Index*.

VINEGAR, Acetum, an agreeable acid, prepared from wine, cyder, beer, and other liquors; of considerable use, both as a medicine and a sauce. The word is French, *vinaigre;* formed from *vin*, "wine;" and *aigre*, "sour." See Acetic *Acid*, and Chemistry *Index*.

Eels in Vinegar. See Animalcule, N° 9.

VINEYARD, a plantation of vines. The best situation of a vineyard is on the declivity of a hill facing the south.

VIO, Thomas de. See Cajetan.

VIOL, a musical instrument of the same form with the violin, and, like that, struck with a bow.

VIOLA, a genus of plants of the class syngenesia; in the natural system arranged under the 29th order, *Campanaceæ*. See Botany *Index*.

VIOLATION, the act of violating, that is, forcing a woman, or committing a rape upon her.—This term is also used in a moral sense, for a breach or infringement of a law, ordinance, or the like.

VIOLET. See Viola, Botany *Index*.

Violet-Crab. See Cancer, Entomology *Index*.

VIOLIN, or Fiddle, a musical instrument mounted with four strings or guts, and struck or played with a bow. The style and sound of the violin is the gayest and most sprightly of all other instruments; and hence it is of all others the fittest for dancing. Yet there are ways of touching it, which render it grave, soft, languishing, and fit for church or chamber music.—It generally makes the treble or highest part in concerts. Its harmony is from fifth to fifth. Its play is composed of bass, counter-tenor, tenor, and treble; to which may be added, a fifth part: each part has four fifths, which rise to a greater seventeenth.

VIOLONCELLO, of the Italians, is properly our fifth violin; which is a little bass violin half the size of the common bass violin, and the strings bigger and longer in proportion; consequently its sound is an octave lower than our bass violin; which has a noble effect in concerts.

VIPER. See Ophiology *Index*.

VIRAGO, a woman of extraordinary stature and courage; who has the mein and air of a man, and performs the actions and exercises of men.

VIRGIL, or Publius Virgilius Maro, the most excellent of all the Latin poets, was the son of a potter of of Andes, near Mantua, where he was born, 70 years B. C. He studied first at Mantua; then at Cremona, Milan, and Naples; whence going to Rome, he acquired the esteem of the greatest wits and most illustrious persons of his time; and among others of the emperor Augustus, Mæcenas, and Pollio. He was well skilled not only in polite literature and poetry, but also in philosophy, the mathematics, geography, medicine, and natural history. Though one of the greatest geniuses of his age, and the admiration of the Romans, he always preserved a singular modesty, and lived chaste at a time when the manners of the people were extremely corrupt. He carried Latin poetry to such a high perfection, that he was justly esteemed the prince of Latin poets. He first turned himself to pastoral; and being captivated with the beauty and sweetness of Theocritus, was ambitious to introduce this new species of poetry among the Romans. His first performance in this way is supposed to have been written U. C. 709, the year before the death of Julius Cæsar, when the poet was in his 25th year: it is intitled *Alexis*. Possibly *Palæmon* was his second: it is a close imitation of the fourth and fifth Idylls of Theocritus. Mr Wharton places *Silenus* next; which is said to have been publicly recited on the stage by Cytheris, a celebrated comedian. Virgil's fifth eclogue is composed in allusion to the death and deification of Cæsar. The battle of Philippi in 712 having put an end to the Roman liberty, the veteran soldiers began to murmur for their pay; and Augustus, to reward them, distributed among them the lands of Mantua and Cremona. Virgil was involved in this common calamity; and applied to Varus and Pollio, who warmly recommended him to Augustus, and procured for him his patrimony again. Full of gratitude to Augustus, he composed the *Tityrus*, in which he introduces two shepherds; one of them complaining of the distraction of the times, and of the havock the soldiers made among the Mantuan farmers; the other rejoicing for the recovery of his estate, and promising to honour as a god the person who restored it to him. But our poet's joy was not of long continuance; for we are told, that when he returned to take possession of his farm, he was violently assaulted by the intruder, and would certainly have been killed by him if he had not escaped by swimming hastily over the Mincio. Upon this unexpected disappointment, he returned to Rome to renew his petition; and during his journey seems to have composed his ninth eclogue. The celebrated eclogue, intitled *Pollio*, was composed U. C. 714, upon the following occasion: The consul Pollio on the part of Antony, and Mæcenas on the part of Cæsar, had made up the differences between them; by agreeing, that Octavia, half-sister to Cæsar, should be given in marriage to Antony. This agreement caused an universal joy; and Virgil, in his eclogue, testified his. Octavia was with child by her late husband Marcellus at the time of this marriage; and whereas the Sibylline oracles had foretold, that a child was to be born about this time, who should rule the world, and establish perpetual peace, the poet ingeniously supposes the child in Octavia's womb to be the glorious infant, under whose reign mankind was to be happy, the golden age to return from heaven, and fraud and violence to be no more. In this celebrated poem, the author, with great delicacy at the same time, pays his court to both the chiefs, to his patron Pollio, to Octavia, and to the unborn infant. In 715, Pollio was sent against the Parthini, a people of Illyricum; and during this expedition, Virgil addressed to him a beautiful eclogue, called *Pharmaceutria*. His tenth and last eclogue was addressed to Gallus.

In his 34th year, he retired to Naples, and laid the plan of his Georgics; which he undertook at the intreaties of Mæcenas, to whom he dedicated them. This wise and able minister resolved, if possible, to revive the decayed spirit of husbandry; to introduce a taste for agriculture, even among the great; and could not think of a better method to effect this, than to recommend it by the insinuating charms of poetry. Virgil fully answsred the expectations of his patron by his Georgics. They are divided into four books. Corn and ploughing are the subject of the first, vines of the second, cattle of the third, and bees of the fourth.

He is supposed to have been in his 45th year when he began to write the Æneid; the design of which was to reconcile the Romans to the government of Augustus. Augustus was eager to peruse this poem before it was finished; and intreated him by letters to communicate it. Macrobius has preserved to us part of one of Virgil's answers to the emperor, in which the poet excuses himself: who, however, at length complied, and read himself the sixth book to the emperor; when Octavia, who had just lost her son Marcellus, the darling of Rome, and adopted son of Augustus, made one of the audience. Virgil had artfully inserted that beautiful lamentation for the death of young Marcellus, beginning with—*O nate, ingentem luctum ne quære tuorum*—but suppressed his name till he came to the line —*Tu Marcellus eris:* upon hearing which, Octavia could bear no more, but fainted away, overcome with surprise and sorrow. When she recovered, she made the poet a present of ten sesterces for every line, which amounted in the whole to above 2000l.

The Æneid being brought to a conclusion, but not to the perfection our author intended to give it, he resolved to travel into Greece, to correct and polish it at leisure. It was probably on this occasion that Horace addressed that affectionate ode to him, *Sic te Divæ potens Cypri, &c.* Augustus returning victorious from the east, met with Virgil at Athens, who thought himself obliged to attend the emperor to Italy: but the poet was suddenly seized with a fatal distemper, which being increased by the agitation of the vessel, put an end to his life as soon as he landed at Brundusium, in his 52d year. He had ordered in his will, that the Æneid should be burnt as an unfinished poem; but Augustus forbade it, and had it delivered to Varius and Tucca, with the strictest charge to make no additions, but only to publish it correctly. He died with such steadiness and tranquillity, as to be able to dictate his own epitaph in the following words:

Mantua me genuit: Calabri rapuere, tenet nunc
Parthenope: cecini Pascua, Rura, Duces.

His bones were carried to Naples, according to his earnest request; and a monument was erected at a small distance from the city.

Virgil was of a swarthy complexion, tall, of a sickly constitution, and afflicted with frequent headachs, and spitting of blood. He was so very bashful, that he often ran into the shops to prevent being gazed at in the streets;

streets; yet was so honoured by the Roman people, that once coming into the theatre, the whole audience rose up out of respect to him. He was of a thoughtful and melancholy temper; he spoke little, and loved retirement and contemplation. His fortune was affluent; he had a fine house and well furnished library near Mæcenas's gardens, on the Esquiline mount at Rome, and also a delightful villa in Sicily. He was so benevolent and inoffensive, that most of his contemporary poets, though they envied each other, agreed in loving and esteeming him. He revised his verses with prodigious severity; and used to compare himself to a she bear, which licked her cubs into shape.

The best edition of Virgil's works are those of Mosvicius, with the notes of Servius, printed at Lewarden in 1717, two vols 4to; and that of Burman, at Amsterdam, 1746, in four vols 4to. There are several English translations, which are well known.

VIRGIL, *Polydore*, an English historian, born at Urbino in Italy, was sent in the beginning of the 16th century by Pope Alexander VI. as sub-collector of the Papal tax, called *Peter-pence*, in this kingdom. He had not been long in England before he obtained preferment in the church; for in 1503 he was presented to the rectory of Church-Langton in the archdeaconry of Leicester. In 1507 he was collated to the prebend of Scamlesby in the church of Lincoln; and in the same year was made archdeacon of Wells, and prebendary of Hereford. In 1513, he resigned his prebend of Lincoln, and was collated to that of Oxgate in St Paul's, London. We are told, that on his preferment to the archdeaconry of Wells, he resigned the office of sub-collector to the pope, and determined to spend the remainder of his life in England, the History of which kingdom he began in the year 1505, at the command of Henry VII. That work cost him 12 years labour. In 1526, he finished his treatise on Prodigies. Polydore continued in England during the whole reign of Henry VIII. and part of that of Edward VI. whence it is concluded that he was a moderate Papist. In 1550, being now an old man, he requested leave to revisit his native country. He was accordingly dismissed with a present of 300 crowns, together with the privilege of holding his preferments to the end of his life. He died at Urbino in the year 1555. As an historian, he is accused by some as a malignant slanderer of the English nation; yet Jovius remarks, that the French and Scotch accuse him of having flattered that nation too much: (See his *Elog*. cap. 135. p. 179.). Besides the above, he wrote, 1. *De Rerum Inventoribus;* of which an English translation was published by Langley in 1663. It was also translated into French and Spanish. 2. *De Prodigiis et Sortibus*. 3. *Episcoporum Angliæ Catalogus*. Manuscript. 4. *De Vita Perfecta*, Basil, 1546, 1553, 8vo. 5. *Epistolæ Eruditæ;* and some other works.

VIRGINIA, one of the United States of the North American republic. It is bounded by the sea and the bay of Chesapeake on the east, by Maryland and Pennsylvania on the north, by Ohio and Kentucky on the west, and by North Carolina on the south. Its greatest length east and west is 350 miles; its breadth 220; and its area is about 56,000 square miles. About one-third of the surface of this state is occupied by the different ridges of the Alleghany chain, which traverse it in the direction of north-east and south-west. These ridges rise to the height of about 3000 feet, and are generally covered with natural wood. That part of the country which lies immediately along the shores of the ocean and the Chesapeake bay is generally flat, sandy, and so poor as to admit of cultivation only on the banks of the rivers. This tract extends about 60 or 80 miles inward. Beyond it, as far as the foot of the Blue ridge or eastern chain of the Alleghanies, the soil is greatly superior, and bears excellent crops of wheat, maize, barley, tobacco, hemp, &c. The soil of of the broad valleys between the Alleghany ridges is similar, and that on the western slope of the mountains reaching to the banks of the Ohio, is believed to be the richest of the whole.

In point of climate, this state is probably one of the most agreeable in North America. The extremes of heat and cold, at Mr Jefferson's seat of Monticello, are 98° above, and 6° below zero. The mean annual temperature at Williamsburg is 57°; and the average annual quantity of rain 47 inches.

It is remarkable that, proceeding on the same parallel of latitude westwardly, the climate becomes colder in like manner as when you proceed northwardly. This continues to be the case till you attain the summit of the Alleghany, which is the highest land between the ocean and the Mississippi. From thence, descending in the same latitude towards the Mississippi, the change reverses; and, if we may believe travellers, it becomes warmer there than it is in the same latitude on the seaside.

The principal rivers of this state are, James's river, which falls into the Chesapeake bay after a course of 270 miles, through the greater part of which it admits of boat navigation; York river; Rappahanock; the Patowmac, which separates Virginia from Maryland; the Shenandoah, which falls into the Patowmac; the Monongahela; the Ohio; and the Kenhawa. These rivers afford a great extent of inland navigation, and have contributed much to the improvement of the state.

Iron and lead ores are found and worked in several places. Native copper, manganese, and antimony, have also been discovered. Lime is abundant on the west side, and coal is found on both sides of the mountains. Salt is also extracted in great quantities from springs on the banks of some of the branches of the Ohio.

The wild animals are now scarce on the east side of the Alleghanies, but the bear, wolf, deer, racoon, opossum, are still numerous in the western parts. There are rattlesnakes and serpents of a large size, but they are rarely met with. The remains of the mammoth have been found also in this state. There are various species of wild fowl, of which the most esteemed are the turkeys. The rivers and bays contain a great variety of fish; with which the towns on the coast are generally well supplied.

This state was first settled in 1607 when the whole inhabitants amounted only to 40 persons. In 1703 they amounted to 60,000; in 1790 to 747,610; and in 1810 to 974,672, including 392,518 slaves. The inhabitants of the upper country are generally much above the average stature of Europeans, and strong and active in proportion. On the coast, where the climate is rather unhealthy, the inhabitants are not so tall or athletic. The Virginians are polite, frank, liberal,

beral, and high spirited; but they are charged with being impetuous, proud, indolent, superficial in their acquirements, addicted to gaming, and lax in their morals. The most prominent defects in their character may be attributed to the debasing influence of slavery.

The legislature consists of a senate and house of delegates; the former composed of 24 members chosen for four years; the latter of two freeholders for each county, and one for each city, chosen annually by the persons possessing land. The executive power is vested in the governor, assisted by a council of eight members chosen annually by both houses of the legislature. The judges are appointed by the legislature, and hold their offices during good behaviour. The clergy are supported by voluntary contributions. The Presbyterians are the most numerous sect.

There are two colleges in this state: That of William and Mary, founded in 1692, is under the direction of 20 governors, who appoint the president and professors, and frame regulations. There are five professorships, viz. law, medicine, mathematics, philosophy, and modern languages. Hampden and Sydney college in Prince Edward county has been lately established. There are academies in all the considerable towns. Hitherto there has been a want of the means of elementary education in this state; but in 1816 the legislature set apart one million of dollars for the support of schools.

The produce of this state consists of tobacco, which is cultivated to a great extent eastward of the Alleghany mountains; maize, or Indian corn, which yields from 12 to 50 bushels an acre; wheat, which yields on an average 15 bushels an acre, being generally raised from land that has been exhausted by crops of tobacco; rice on the borders of the swamps; buck wheat, oats, hemp, and cotton; the last not to a great extent. Potatoes are in general use. Among the fruits are plums, almonds, pomegranates, figs, peaches, and melons. The breeds of cattle and horses are much inferior in general to those of Pennsylvania. Mules and oxen are much employed in agricultural labour. Merino sheep have been introduced, and are extending through the state. Great numbers of hogs are fed on acorns in the woods.

The manufactures of this state are inconsiderable. They consist chiefly of spirits, brewed liquors, salt, cabinet ware, leather, and linen for domestic use. The whole value of manufactures in 1810 was estimated at 12,263,473 dollars.

The exports consist chiefly of tobacco, wheat, maize, lumber, tar, turpentine, beef, pork, peltries, &c. The imports are manufactured articles of all kinds, and West India produce. In 1817 the exports amounted to 5,621,442 dollars, of which 60,204 dollars were for foreign produce, and the rest for articles of domestic growth. In 1815 the shipping belonging to this state amounted to 71,492 tons. The principal trading port is Northfolk; the next in importance is Richmond the capital.

Virginia, like the other states, has advanced rapidly since the revolution; and having still vast tracts of uncleared land, she has yet a great progress to make. The baneful influence of slavery, however, will undoubtedly throw her behind the northern and middle states, and the restrictions on the elective franchise have also a tendency to prevent the industrious classes from settling here. The value of lands and houses in Virginia in 1799 was estimated in the official returns at 71,225,127, and in 1815 at 165,608,199 dollars. But including slaves the value in 1815 was 263,737,699 dollars. Virginia has had the honour of giving four presidents to the republic; Washington, Jefferson, Madison, and Munroe. The two first, as well as several other citizens of this state, have been ranked among most distinguished men whom America has produced.

VIRGO, in *Astronomy*, one of the signs or constellations of the zodiac.

VIRGULA DIVINATORIA, divining rod. See MINE.

VIRTUAL, or POTENTIAL; something that has a power or virtue of acting or doing. The term is chiefly understood of something that acts by a secret invisible cause, in opposition to actual and sensible.

VIRTUE, a term used in various significations. In the general it denotes power, or the perfection of any thing, whether natural or supernatural, animate or inanimate, essential or accessory. But, in its more proper or restrained sense, virtue signifies a habit, which improves and perfects the possessor and his actions. See MORAL PHILOSOPHY, N° 84.

VIRTUOSO, an Italian term lately introduced into the English, signifying a man of curiosity and learning, or one who loves and promotes the arts and sciences. But among us the term seems to be appropriated to those who apply themselves to some curious and quaint rather than immediately useful art or study; as antiquaries, collectors of rarities of any kind, microscopical observers, &c.

VIRULENT, a term applied to any thing that yields a virus; that is, a contagious or malignant pus.

VISCERA, in *Anatomy*, a term signifying the same with entrails; including the heart, liver, lungs, spleen, intestines, and other inward parts of the body.

VISCIDITY, or VISCOSITY, the quality of something that is viscid or viscous; that is, glutinous and sticky like bird-lime, which the Latins call by the name of *viscus*.

VISCOUNT (*Vice Comes*), was anciently an officer under an earl, to whom, during his attendance at court, he acted as deputy to look after the affairs of the country. But the name was afterwards made use of as an arbitrary title of honour, without any shadow of office pertaining to it, by Henry VI.: when in the 18th year of his reign, he created John Beaumont a peer by the name of *Viscount Beaumont;* which was the first instance of the kind.

A viscount is created by a patent as an earl is; his title is *Right Honourable;* his mantle is two doublings and a half of plain fur; and his coronet has only a row of pearls close to the circle.

VISCUM, a genus of plants of the class diœcia, and in the natural system arranged under the 48th order, *Aggregatæ*. See BOTANY *Index*.

VISHNOU, that person in the triad of the Bramins who is considered as the *preserver* of the universe. *Brahma* is the creator, and *Siva* the destroyer; and these two, with Vishnou, united in some inexplicable manner, constitute *Brahme*, or the supreme numen of the Hindoos. See POLYTHEISM, N° 36.

VISIBLE, something that is an object of sight or vision; or something whereby the eye is affected so as to produce this sensation.

VISIER, an officer or dignitary in the Ottoman empire,

pire, whereof there are two kinds; one called by the Turks *Visier-azem*, that is, "grand visier," is the prime minister of state in the whole empire. He commands the army in chief, and presides in the divan or great council. Next to him are six other subordinate visiers, called *visiers of the bench;* who officiate as his counsellors or assessors in the divan.

VISION, in *Optics*, the act of seeing or perceiving external objects by means of the organ of sight, the eye. See ANATOMY, N° 142, and METAPHYSICS, N° 49—54.

VISTULA, or WEISEL, a large river of Poland, which taking its rise in the mountains south of Silesia, visits Cracow, Warsaw, &c. and continuing its course northward, falls into the Baltic sea below Dantzic.

VISUAL, in general, something belonging to vision.

VITAL, in *Physiology*, an appellation given to whatever ministers principally to the constituting or maintaining life in the bodies of animals: thus the heart, lungs, and brain, are called *vital parts;* and the operations of these parts by which the life of animals is maintained are called *vital functions*.

VITELLUS, the yolk of an egg.

VITIS, or VINE, a genus of the class pentandria, and in the natural system arranged under the 46th order, *Hederaceæ*. See BOTANY *Index;* and for its culture, see GARDENING.

VITREOUS HUMOUR OF THE EYE. See ANATOMY, N° 142.

VITRIFICATION, in *Chemistry*, the conversion of a body into glass by means of fire. See GLASS.

VITRIOL, a compound salt, formed by the union of iron, copper, or zinc, with sulphuric acid; hence called from the colours white, blue, and green, according to the metal. See CHEMISTRY.

VITRIOLATED, among chemists, something impregnated, or supposed to be so, with vitriol or its acid.

VITRIOLIC ACID. See *SULPHURIC Acid* and CHEMISTRY *Index*.

VITRUVIUS POLLIO, MARCUS, a very celebrated Roman architect, was, according to the common opinion, born at Verona, and lived in the reign of Augustus, to whom he dedicated his excellent treatise on architecture, divided into ten books. William Philander's edition of this celebrated work is esteemed. Claudius Perrault has given an excellent translation of it in French, with learned notes. There are also several English translations of Vitruvius.

VITUS'S DANCE. See MEDICINE, N° 284.

VIVERRA, the WEASEL; a genus of quadrupeds belonging to the order of feræ. See MAMMALIA *Index*.

VIVES. See FARRIERY.

VIVIPAROUS, in *Natural History*, an epithet applied to such animals as bring forth their young alive and perfect; in contradistinction to those that lay eggs, which are called *oviparous* animals.

UKRAINE, a large country of Europe, lying on the borders of Turkey in Europe, Poland, Russia. and Little Tartary. Its name properly signifies a *frontier*. By a treaty between Russia and Poland in 1693, the latter remained in possession of all that part of the Ukraine lying on the west side of the river Dnieper, which is but indifferently cultivated; while the country on the east side, inhabited by the Cossacs, is in much better condition. The Russian part is comprised in the government of Kiof; and the empress of Russia having obtained the Polish palatinate of Kiof, by the treaty of partition in 1793, the whole of the Ukraine, on both sides of the Dnieper, belongs now to that ambitious and formidable power. The principal town is Kiof.

ULCER, in *Surgery*. See SURGERY *Index*.

ULCER, in *Farriery*. See FARRIERY.

ULEX, a genus of plants of the class of diadelphia, and in the natural system arranged under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

ULIETEA, one of the Society islands in the South sea. This island is about 21 leagues in circuit. Its productions are plantains, cocoa-nuts, yams, hogs, and fowl; the two latter of which are scarce. The soil on the top of one of the hills was found to be a kind of stone marle; on the sides were found some scattered flints, and a few small pieces of a cavernous or spongy stone lava, of a whitish colour, which seemed to contain some remains of iron, so that it may possibly be here lodged in the mountains in a great quantity. Nothing was seen on this island to distinguish either its inhabitants, or their manners, from the other neighbouring islands. The first Europeans who landed on this shore were Mr (now Sir Joseph) Banks and Dr Solander; they were received by the natives in the most courteous manner, reports concerning them having been their harbingers from Otaheite. Every body seemed to fear and respect them, placing in them at the same time the utmost confidence: behaving, as if conscious that their visitors possessed the power of doing them mischief without a disposition to make use of it.

ULIGINOUS, in *Agriculture* an appellation given to a moist, moorish, and fenny soil.

ULLAGE, in gauging, is so much of a cask or other vessel as it wants of being full.

ULM, formerly a free and imperial city of Germany, but now belonging to Bavaria. It is a pretty large place, defended by fortifications; and the inhabitants, who are chiefly Protestants, amounted to 14,000 in 1800. The town is seated on the Danube, a little above the confluence of that river and the Iller, and carries on a considerable trade. It has many handsome buildings. The principal church is a magnificent Gothic edifice, and is said to surpass all the cathedrals in Germany in height. The Roman Catholics have but two churches, all the rest belonging to the Protestants. E. Long. 9. 59. N. Lat. 48. 25.

ULMUS, a genus of plants belonging to the class of pentandria; and in the natural system arranged under the 53d order, *Scabridæ*. See BOTANY *Index*.

ULSTER, the most northerly province of Ireland. In Latin it is called *Ultonia*, in Irish *Cui Guilly*; and gives the title of *earl* to the dukes of York of the royal family. It is bounded by the Atlantic ocean on the west, St George's channel and the Irish sea on the east, the Deucaledonian ocean on the north, and on the south and south-west the provinces of Leinster and Connaught. Its greatest length is near 120 miles, its breadth about 100; and its circumference, including the windings and turnings, 460; containing 9 counties, 58 market-towns and boroughs, 1 archbishopric, 6 bishoprics, and 214 parishes. Ulster abounds in lakes and rivers, which supply it with variety of fine fish, especially salmon, besides what it has from the sea, with which a great part of it is bounded. The southern parts of it are rich, fertile,

tile, well cultivated, and inclosed; but the greater part of the northern is open and mountainous.—The towns of this province are in general the neatest and best built of any in Ireland, as well as the farm-houses; which in most parts of the kingdom are constructed of no better materials than clay and straw. The inhabitants of Ulster are also more like the English in their manners and dialect than those of the other three provinces: for as it includes within itself the whole, or by far the greater part, of the linen manufactory, the best branch of trade in the kingdom, they have consequently the greatest intercourse with England. An Englishman, in some parts of it, indeed, will imagine himself, from the similarity of their language and manners, in his own country. This province had anciently petty kings of its own. It was first subjected to the English in the reign of Henry II. by John Courcy, the first who bore the title of *earl of Ulster;* but it afterwards threw off the yoke, and was never entirely reduced till the reign of James I. when great numbers of Scots by his encouragement went and settled in it. Of these, most of the present inhabitants are the descendants. This province was the first and principal scene of the bloody massacre in 1641. See ULSTER, SUPPLEMENT.

ULTERIOR, in *Geography*, is applied to some part of a country or province, which, with regard to the rest of that country, is situated on the farther side of the river, mountain, or other boundary which separates the two countries.

ULTRAMARINE, a beautiful blue colour used by the painters, prepared from the lapis lazuli by calcination. See LAZULITE, MINERALOGY *Index*.

ULTRAMONTANE, something beyond the mountains. The term is principally applied in relation to France and Italy, which are separated by the Alps.

ULVA, a genus of plants of the class of cryptogamia. See BOTANY *Index*.

ULUG BEIG, a Persian prince and learned astronomer, was descended from the famous Tamerlane, and reigned at Samarcand about 40 years; after which he was murdered by his own son in 1449. His catalogue of the fixed stars, rectified for the year 1434, was published at Oxford by Mr Hyde, in 1665, with learned notes. Mr Hudson printed in the English Geography Ulug Beig's Tables of the Longitude and Latitude of Places; and Mr Greaves published, in Latin, his Astronomical Epochas, at London, in 1650. See ASTRONOMY *Index*.

ULYSSES, king of Ithaca, the son of Laertes, and father of Telemachus, and one of those heroes who contributed most to the taking of Troy. After the destruction of that city, he wandered for 10 years; and at last returned to Ithaca, where, with the assistance of Telemachus, he killed Antinous and other princes who intended to marry his wife Penelope and seize his dominions. He at length resigned the government of the kingdom to his son Telemachus; and was killed by Telegonus, his son by Circe, who did not know him. This hero is the subject of the Odyssey.

UMBELLA, an UMBEL, a species of receptacle; or rather a mode of flowering, in which a number of slender footstalks proceed from the same centre, and rise to an equal height, so as to form an even and generally round surface at top. See BOTANY.

UMBELLATÆ, the name of a class in Ray's and Tournefort's methods, consisting of plants whose flowers grow in umbels, with five petals that are often unequal, and two naked seeds that are joined at top and separated below.

The same plants constitute the 45th order of Linnæus's Fragments of a Natural Method. See BOTANY.

UMBELLIFEROUS PLANTS, are such as have their tops branched and spread out like an umbrella.

UMBER, or UMBRE, a fossil brown or blackish substance, used in painting. See MINERALOGY *Index*.

UMBILICAL, among anatomists, something relating to the umbilicus or navel.

UMBRELLA, a moveable canopy, made of silk or other cloth spread out upon ribs of whale-bone, and supported by a staff, to protect a person from rain, or the scorching beams of the sun.

UMPIRE, a third person chosen to decide a controversy left to arbitration.

UNCIA, in general, a Latin term, denoting the twelfth part of any thing; particularly the twelfth part of a pound, called in English an *ounce;* or the twelfth part of a foot, called an *inch*.

UNCTION, the act of anointing or rubbing with oil or other fatty matter.

UNCTION, in matters of religion, is used for the character conferred on sacred things by anointing them with oil. Unctions are very frequent among the Hebrews. They anointed both their kings and high-priests at the ceremony of their inauguration. They also anointed the sacred vessels of the tabernacle and temple, to sanctify and consecrate them to the service of God. The unction of kings is supposed to be a ceremony introduced very late among the Christian princes. It is said that none of the emperors were ever anointed before Justinian or Justin. The emperors of Germany took the practice from those of the eastern empire: King Pepin of France was the first who received the unction. In the ancient Christian church, unction always accompanied the ceremonies of baptism and confirmation. Extreme unction, or the anointing persons in the article of death, was also practised by the ancient Christians, in compliance with the precept of St James, chap. v. 14th and 15th verses; and this extreme unction the Romish church has advanced to the dignity of a sacrament. It is administered to none but such as are affected with some mortal disease, or in a decrepit age. It is refused to impenitent persons, as also to criminals. The parts to be anointed are the eyes, the ears, the nostrils, the mouth, the hands, the feet, and the reins. The laity are anointed in the palms of the hands, but priests on the back of it; because the palms of their hands have been already consecrated by ordination.

The oil with which the sick person is anointed represents the grace of God, which is poured down into the soul, and the prayer used at the time of anointing expresses the remission of sins thereby granted to the sick person; for the prayer is this: "By this holy unction, and his own most pious mercy, may the Almighty God forgive thee whatever sins thou hast committed *by the sight*," when the eyes are anointed; *by the hearing*, when the ears are anointed; and so of the other senses *.

* *The Sincere Christian instructed from the Written Word.*

UNDECAGON, is a regular polygon of 11 sides.

UNDECEMVIR, a magistrate among the ancient Athenians, who had 10 other colleagues or associates joined with him in the same commission. The functions of the undecemviri at Athens were much the same with those of the late *prevots de marechaussee* in France. They took care of the apprehending of criminals; secured them in the hands of justice; and when they were condemned, took them again into custody, that the sentence might be executed on them. They were chosen by the tribes, each tribe naming its own; and as the number of the tribes after Callisthenes was but 10, which made 10 members, a scribe or notary was added, which made the number 11.

UNDERSTANDING. See METAPHYSICS and LOGIC.

UNDERWALDEN, a canton of Switzerland, and the sixth in rank. It is bounded on the north by the canton of Lucern and by the lake of the Four Cantons, on the east by the high mountains which separate it from the canton of Bern, and on the west by the canton of Bern. The religion of this canton is the Roman Catholic.

UNDULATION, in *Physics*, a kind of tremulous motion or vibration observable in a liquid, by which it alternately rises and falls like the waves of the sea.

UNGUENT, or OINTMENT, in *Medicine* and *Surgery*, a tropical remedy or composition, chiefly used in the dressing of wounds or blisters. See MATERIA MEDICA.

UNICORN, an animal famous among the ancients, and thought to be the same with the rhinoceros.

Sparmann informs us, that the figure of the unicorn described by the ancients has been found delineated by the Snese Hottentots on the plain surface of a rock in Caffraria; and therefore conjectures, that such an animal either does exist at present in the internal parts of Africa, or at least once did so. Father Lobo affirms that he has seen it. Mr Barrow, in his *Travels in Southern Africa*, affords additional reason to believe in the existence of this curious animal.

UNICORN-Fish. See MONODON, CETOLOGY *Index*.

UNIFORM, denotes a thing to be similar, or consistent either with another thing, or with itself, in respect of figure, structure, proportion, or the like; in which sense it stands opposed to difform.

UNIFORMITY, regularity, a similitude or resemblance between the parts of a whole. Such is that we meet with in figures of many sides, and angles respectively equal, and answerable to each other. A late ingenious author makes beauty to consist in uniformity, joined or combined with variety. Where the uniformity is equal in two objects, the beauty, he contends, is as the variety; and where the variety is equal, the beauty is as the uniformity.

UNIFORMITY, is particularly used for one and the same form of public prayers, and administration of sacraments, and other rites, &c. of the church of England, prescribed by the famous stat. 1. Eliz. and 13 and 14 Car. II. cap. 4. called the *Act of Uniformity*. See LITURGY.

UNION, a junction, coalition, or assemblage of two or more different things in one.

UNION, or *The Union*, by way of eminence, is more particularly used to express the act by which the two separate kingdoms of England and Scotland were incorporated into one, under the title of *The kingdom of Great Britain*. This union, in vain attempted by King James I. was at length effected in the year 1707, 6 Annæ, when 25 articles were agreed to by the parliament of both nations; the purport of the most considerable being as follows:

1. That on the first of May 1707, and for ever after the kingdoms of England and Scotland shall be united into one kingdom, by the name of *Great Britain*.

2. The succession to the monarchy of Great Britain shall be the same as was before settled with regard to that of England.

3. The united kingdom shall be represented by one parliament.

4. There shall be a communication of all rights and privileges between the subjects of both kingdoms, except where it is otherwise agreed.

9. When England raises 2,000,000l. by a land tax, Scotland shall raise 48,000l.

16, 17. The standards of the coin, of weights, and of measures, shall be reduced to those of England throughout the united kingdoms.

18. The laws relating to trade, customs, and the excise, shall be the same in Scotland as in England. But all the other laws of Scotland shall remain in force; but alterable by the parliament of Great Britain. Yet with this caution, that laws relating to public policy are alterable at the discretion of the parliament; laws relating to private right are not to be altered but for the evident utility of the people of Scotland.

22. Sixteen peers are to be chosen to represent the peerage of Scotland in parliament, and 45 members to sit in the house of commons.

23. The 16 peers of Scotland shall have all privileges of parliament; and all peers of Scotland shall be peers of Great Britain, and rank next after those of the same degree at the time of the union, and shall have all privileges of peers, except sitting in the house of lords, and voting on the trial of a peer.

These are the principal of the 25 articles of union, which are ratified and confirmed by statute 5 Ann. c. 8. in which statute there are also two acts of parliament recited; the one of Scotland, whereby the church of Scotland, and also the four universities of that kingdom, are established for ever, and all succeeding sovereigns are to take an oath inviolably to maintain the same; the other of England, 5 Annæ, c. 6. whereby the acts of uniformity of 13 Eliz. and 13 Car. II. (except as the same had been altered by parliament at that time), and all other acts then in force for the preservation of the church of England, are declared perpetual; and it is stipulated, that every subsequent king and queen shall take an oath inviolably to maintain the same within England, Ireland, Wales, and the town of Berwick-upon-Tweed. And it is enacted, that these two acts "shall for ever be observed as fundamental and essential conditions for the union."

Upon these articles and act of union, it is to be observed, 1. That the two kingdoms are so inseparably united, that nothing can ever disunite them; except the mutual consent of both, or the successful resistance of either, upon apprehending an infringement of those points which, when they were separate and independent nations, it was mutually stipulated should be "fundamental and essential conditions of the union." 2. That whatever else may be deemed "fundamental and essential conditions," the preservation of the two churches, of England and Scotland, in the same state that they were in at the time of the union, and the maintenance of

Union ‖ United Brethren.

of the acts of uniformity which established the liturgy, are expressly declared so to be. 3. That therefore any alteration in the constitution of either of these churches, or in the liturgy of the church of England (unless with the consent of the respective churches, collectively or representatively given), would be an infringement of these "fundamental and essential conditions," and greatly endanger the union. 4. That the municipal laws of Scotland are ordained to be still observed in that part of the island, unless altered by parliament; and as the parliament has not yet thought proper, except in a few instances, to alter them, they still, with regard to the particulars unaltered, continue in full force.

For an account of the union of Ireland with Great Britain, thus forming the *united kingdom of Great Britain and Ireland*, see IRELAND, N° 120.

UNISON, in *Music*. See INTERVAL.

UNIT, or UNITY, in *Arithmetic*, the number one; or one single individual part of discrete quantity.

UNITARIANS, in ecclesiastical history, a name given to those who confine the glory and attribute of divinity to the One only great and supreme God, and Father of our Lord Jesus Christ.

UNITED BRETHREN, or *Unitas Fratrum*, a society of Christians, whose chief residence is at Herrnhut in Saxony. They are commonly called Moravians from their original country, and Herrnhuters, from their chief place of residence. Some account of this society has already been given under HERRNHUT; but as that account may, by some, not be deemed sufficiently full, we shall here add a summary of their institutes, derived from a communication by one of their own clergy.

Though the church of the United Brethren is episcopal, their bishops possess no elevation of rank or pre-eminent authority, their church being governed by synods or consistories from all the congregations, and by subordinate bodies, called conferences. The synods are generally held once in seven years. In the first sitting a president is chosen; and the elders appointed by the former synod to superintend the unity, lay down their office, though they still form a part of the assembly, as well as the bishops, the lay elders, and those ministers who have the inspection of several congregations in one province.

Questions of importance, or of which the consequences cannot be foreseen, are decided by lot, though this is never used till after mature deliberation and fervent prayer. In the synods, the state of the unity, and the concerns of the congregations and missions, are taken into consideration.

Towards the conclusion of every synod, a kind of executive board is appointed, called the *elders conference of the unity*, consisting of 13 elders, and divided into four committees or departments, one for superintending missions into heathen countries; a second for watching over the conduct of congregations; a third for managing the economical concerns of the unity, and a fourth for maintaining the discipline of the society. These conferences, however, are amenable to a higher committee, called the elders conference, the powers of which are very extensive. It appoints and removes every servant in the unity, authorises the bishops to ordain presbyters or deacons, and to consecrate other bishops, and in short, possesses the supreme executive power over the whole society.

United Brethren, United Provinces.

A bishop of the United Brethren can discharge no office but by the appointment of the synod, or of the elders conference. Indeed their deacons can perform every office of the bishops, except ordination, and appear to confirm young persons when they first become candidates for the communion. Even female deacons are employed for the purpose of privately admonishing their own sex, and visiting them in cases of sickness. There are also lay elders, whose business it is to watch over the constitution and discipline of the unity; to enforce the observance of the laws of the country in which missions are established, and to guard the privileges conferred on the brethren by the government under which they live.

On Sunday, besides the public prayers, one or two sermons are preached in every church, and after the morning service, an exhortation is given to the children. Previous to the holy communion, which is administered on some Sunday once a month, and on Maunday Thursday, each person, before he communicates, must converse on the state of his soul with one of the elders. Love feasts are frequent, and on Maunday Thursday the society have a solemn foot-washing.

Our limits will not permit us to give a systematic view of the doctrinal tenets of the Brethren. Though they acknowledge no other standard of truth than the sacred scriptures, they adhere to the Augsburg confession, and speak respectfully of the 39 articles of the church of England. They profess to believe that the kingdom of Christ is not confined to any particular party, community, or church; and they consider themselves as spiritually joined in the bond of Christian love to all who are taught of God, and belong to the universal church of Christ, however much they may differ in forms, which they deem non-essentials. For a fuller account of this society, see Crantz's Ancient and Modern History of the Protestant Church of the United Brethren, London 1780, and An Exposition of Christian Doctrine, as taught in the Protestant Church of the United Brethren, London 1784.

UNITED PROVINCES, otherwise called the *Republic of Holland*, or the *Batavian republic*, a maritime country of Europe, occupying that part of the Netherlands which lies between Austrian Flanders and Brabant, now forming a part of the kingdom of the Netherlands, which was erected in 1814. It is bounded on the north and west by the German ocean or North sea, and on the east by Westphalia. These provinces are situated between the parallels of 51° 10′, and 53° 35′ N. Lat. and between 3° 10′, and 7° 5′ E. Long. In British miles the length of this country from north to south, is estimated at 165, its breadth from west to east about 100, and its area at 10,000 square miles. 1 Situation and extent.

Before the French revolution, this part of the Low Countries was divided into seven provinces, viz. GUELDERLAND or GELDERS, HOLLAND, ZEALAND, UTRECHT, FRIESLAND, OVERYSSEL and GRONINGEN, besides the dependencies of *Dutch* BRABANT and *Dutch* FLANDERS. During the time the country was incorporated with France, it was divided into eight departments. The following table gives a general view of the subdivisions, area in geographical miles, population and chief towns of these provinces. 2 Division.

Provinces.	Subdivisions.	Area.	Population in 1796.	Chief Towns.
I. GUELDERLAND.	Nimeguen, Zutphen, Arnheim	1840	217,828	NIMEGUEN, Zutphen, Arnheim.
II. HOLLAND.	North Holland, South Holland	2000	828,542	AMSTERDAM, Rotterdam, Hague, Leyden, Haarlem, Helvoetsluys and Alkmaer.
III. ZEALAND.	West Zealand, East Zealand	uncertain	82,212	MIDDLEBURG, Flushing.
IV. UTRECHT.	Emeland, Abhoude, Montfort, Wyk	510	92,904	UTRECHT, Amersfort.
V. FRIESLAND.	Oostergo, Westergo, Zevenwolde, Northern islands	1155	161,513	LEEWARDEN, Dockum, Franeker, Harlingen, Bolswert.
VI. OVERYSSEL.	Salland, Twenthe, Woollenhoven, Drenthe	1792	135,060	DEVENTER, Zwol, Campen, Coeverden.
VII. GRONINGEN.	Groningen, Ommeland	640	114,555	GRONINGEN, Winchoten.
GENERALITY lands (A)	Drent, Dutch Brabant	2000	247,849	Bois-le-duc, Breda, Bergen-op-Zoom.
			1,880,563	

A great part of these provinces is composed of islands formed by the mouths of the large rivers which here disembogue their waters into the German ocean. The principal islands are *Walcheren*, *Joostland*, *South* and *North Beveland*, and *Wolfersdyk*, composing West Zealand; *Schowen*, *Duiveland*, *Fertholen*, and *St Phillipsland*, forming East Zealand; *Goeree* in *South Holland*, the *Texel*, *Vlieland*, and *Ameland*, to the west and north of Friesland.

3 Colonies. The Dutch had formerly considerable colonial territory; but this is now reduced to Java, Sumatra, and the Molucca islands, with some other settlements in the East Indies; some trifling factories on the Guinea coast; St Eustatius and part of Surinam in South America.

4 Surface, soil, &c. The face of the country is, in general, extremely uniform, consisting of large tracts of marshy pastures, or sandy heaths, interspersed with several large rivers, and numerous canals. There are a few hills in the eastern districts, but the coasts are so low, that, but for the *dykes* or sea walls, they would be inundated by the sea. The soil consists almost entirely of *alluvial* earth and vegetable mould, and is very productive. The climate is moist, inconstant, and peculiarly insalubrious to strangers; intermittent fevers and similar diseases, the attendants on a marshy and watery soil, being extremely frequent. The winters are colder and the summers hotter than in Britain.

5 Rivers and lakes. The principal rivers of the United Provinces are the Rhine, the Maese or Meuse, and the Escaut or Scheldt, which separates them from French Flanders. There are few lakes of any note, except the sea of Haerlem, near the Zuyder Zee.

There is little interesting in the natural history of Holland; the animals and plants resembling those of the adjacent countries of France and Germany and its mineral products being extremely few. Its chief artificial products are flax, tobacco, madder and flower roots, butter and cheese. The state of agriculture is but little advanced; as almost the whole country is under grass, and the corn produced is not nearly sufficient for home consumption. 6 Produce and agriculture.

The changes which the coasts of the Dutch provinces have undergone, in consequence of the shifting of the beds of rivers, the encroachments or retiring of the sea, and tempests from the German ocean, render their progressive geography an interesting object. We find that in the latter periods of the Roman empire, the river Rhine divided itself into two great branches at Burginasium, the modern Schenk, about five miles north-west of Colonia Trajana, near the present Cleves. The southern branch joined the Meuse at the town of Mosa or Muvi, while the northern branch passed by Durstadt, Utrecht, and Leyden, to the ocean. The northern branch of the Rhine was joined to the Yssel by the canal of Drusus (see BATAVORUM *Insula*), while this latter river flowed into a considerable lake called Flevo, now a southern portion of the Zuyder Zee. When the canal of Drusus was 7 Progressive geography.

(A) See each of these articles in the general alphabet.

United Provinces. was neglected, the waters of the Rhine poured into the Yssel with such violence as to increase the lake of Flevo to a great expanse of waters, so that instead of a river which once ran from that lake to the sea for nearly 50 Roman miles, there was opened the wide gulf which now forms the entrance. In the mean time, the northern branch of the Rhine became much diminished, and the canal of Drusus gradually disappeared. The estuaries of the Meuse and the Scheldt being open to great inroads from the sea, have also materially changed their figure and position; and the latter in particular, which once formed merely a triangular island, divided into four or five smaller branches, which are now extensive creeks, dividing the islands of Zealand and South Holland. In the beginning of the 15th century, the estuary of the Meuse suddenly formed a vast lake to the south-east of Dort, overwhelming 72 villages, and 100,000 inhabitants. By a subsequent change, the Rhine was again subdivided, the northern branch falling into the Leck, while the southern formed the modern Waal.

The early history of these provinces, from their subjection by the Romans, till they fell under the dominion of the Spanish monarchy, has been already given under the article NETHERLANDS, so that we have here to relate only those transactions which have taken place since the accession of Philip II. to the crown of Spain (B).

8 State of the Dutch provinces at the accession of Philip II. An. 1556.

At the death of Charles V. the Dutch provinces were in a very flourishing condition. In this small tract were then reckoned not fewer than 350 large walled cities, and 6300 considerable towns or large villages, all become rich by their application to arts and commerce. The same application had diffused a spirit of independence among the inhabitants, who were jealously alive to every invasion of their rights and privileges. The reformed religion had made considerable progress among all ranks, and the doctrines of Calvin had been embraced by a great majority of the people. Hence, nothing could be more impolitic than the measures taken by Philip to advance the cause of popery, and to enforce obedience to the tyrannical acts of his deputies. The establishment of a court of inquisition, the increase of the number of bishoprics, the appointment of Cardinal Grandvele to be chief counsellor to the duchess of Parma, then regent of the Netherlands, and the enormous taxes levied to support the Spanish forces, were no trifling grievances, and created such a spirit of disaffection, that when the duchess assumed the reins of government, in the year 1560, the murmurs of the people could no longer be suppressed.

9 Discontent occasioned by the tyrannical measures of Philip. An. 1564.

A deputation of the malcontents, at the head of whom were William prince of Orange, and his brother Louis of Nassau, with the counts of Egmont and Horn, waited on the duchess at Brussels, and insisted either on the dismissal of Cardinal Grandvele, or the calling of an assembly of the states-general. The duchess thought proper to comply with the former of these requests, but as that minister was succeeded by two of his creatures, who trod exactly in his footsteps, and in particular increased the religious persecutions, and the power of the inquisition, the popular ferment became greater than ever. The patriots sent Count Egmont to Madrid, to lay their grievances before the king; but that monarch with his accustomed insincerity, returned a favourable answer to their remonstrances, without changing any of the obnoxious measures of the government at Brussels. In the mean time the diabolical combination that had been formed between Charles IX. of France and Isabella of Spain, for the massacre of the protestants, which soon after took place, had been whispered in the Low Countries, and in consequence a general association was formed for the purpose of abolishing the court of inquisition. This association, headed by Henry de Brodenrode, a descendant of the earls of Holland, waited on the regent in such a formidable body, that she was obliged to promise the exertion of her utmost influence towards obtaining their demands. It is said, however, that she could obtain no better terms from the bigotted Philip than that heretics should in future be hanged instead of burnt. 10

The people break out into open rebellion.

As the people found that their dutiful remonstrances could obtain no redress, they determined to take into their own hands the necessary reformation. In several towns in Flanders, the people assembled, destroyed churches, pulled down images, and committed other acts of violence. The principal inhabitants, however, while they were preparing to resist the oppressive acts of the government, behaved with more temperance and moderation; a new oath of allegiance had been exacted, and this the counts of Egmont and Horn, probably with a view to temporise, were induced to take, but the prince of Orange steadily refused, and retired into Germany, whither he was followed by great numbers of all ranks and conditions, so that within a few days 100,000 families had left the Low Countries. This emigration so much alarmed the duchess of Parma, that she resigned the regency. 11

Duke of Alva appointed governor of the Netherlands.

The duchess was succeeded by the duke of Alva, who had been sent into the Netherlands with an army of 10,000 veteran troops, to intimidate the people, and enforce obedience to the civil power. We have already drawn the character of this bloody man (see ALVA), and have shewn how well he was calculated to execute the orders of a tyrannical and bigotted master. He no sooner entered on his government than the whole country was filled with terror; Counts Egmont and Horn were ignominiously executed, and the estates of the prince of Orange were confiscated. 12

The prince of Orange takes the command of the patriots.

This prince and his brother had been labouring to support the cause of their injured countrymen among the German

(B) There is no part of the history of nations more interesting in itself, or more replete with useful lessons to rulers and to subjects, than that which records the struggles of a brave people to preserve or regain their liberties and independence. Hence the glorious contest which the Dutch provinces maintained against the power of Spain, and by which they finally triumphed over tyranny and oppression, might well deserve a much fuller detail than our confined limits will enable us to afford. In the compendious view which we have here given of these transactions, we have endeavoured to catch the more prominent features, and thus in some measure preserve the spirit of the picture. We may refer our readers for a minute account of these events to *The Modern Universal History*, vol. xxxi. and Watson's *History of the Reigns of Philip II. and Philip III.*

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German princes, and had raised a detachment of Germans, by which they were enabled to make head against the regent. The prince of Orange, who had been always a favourite with the people, was now rendered more popular in consequence of his sufferings in their cause, and was invited to take the command of the armed bodies which were preparing to resist the duke of Alva.

13
Commencement of hostilities.
An. 1569.

The prince first penetrated into Brabant, and attempted to surprise Ruremond, but was defeated by a detachment of the Spanish army; but his brother soon after overpowered a body of Spaniards, and killed 600. In a subsequent engagement, however, with the main body of Alva's army, Prince Louis was entirely defeated, and all his infantry cut in pieces. The prince of Orange finding that he could not at present keep the field against so formidable an enemy, and that his soldiers deserted in consequence of his ill success and want of pay, was, in 1569, obliged to disband his army, and return to Germany.

14
Cruelty of the duke of Alva.

The duke of Alva did not fail to make the most of his success. All the prisoners taken in the last campaign were put to death, and the 100th part of every man's estate, with a tenth of all merchandise, were exacted as an annual payment from the inhabitants, under the penalty of military execution. The states offered to pay an annual subsidy of 2,000,000 florins, in place of these taxes; but these offers were rejected with disdain.

15
A fleet fitted out by the patriots.
An. 1571.

The people thus driven to despair, were resolved to strain every nerve to resist these oppressive acts. The tradesmen in the towns shut their shops, and the peasants refused to bring provisions to the markets. In the mean time a squadron of ships, which is known by the name of *gueux*, had been fitted out by the prince of Orange, and the command given to Lumey. The trifling success of this squadron, which had captured Briel, in the island of Voorn, and repulsed a force sent against it by the duke of Alva, induced the Zealanders to collect all their ships, and also oppose the enemy at sea. A considerable advantage was gained by this fleet, against a Spanish squadron commanded by the duke of Medina Celi. The duke was entirely defeated, many of his ships were taken, and the Zealanders carried off a booty of nearly 1,000,000 of livres.

16
Successes of the Orange party.

To increase his army, the governor had draughted men from the garrisons of most of the fortified towns, and thus exposed these to the attacks of the patriots. Accordingly, Lewis of Nassau surprised Mons, the count de Bergues gained possession of several towns in Overyssel, Guelderland, and Friesland; while another party of the malcontents made themselves masters of North Holland. The duke of Alva now began to feel that he had gone too far, and attempted, when too late, to conciliate the good opinion of the people. He published an edict consenting to remit the most oppressive taxes, if the state could suggest any other method of raising the necessary supplies, and he convoked the states-general of the Provinces to assemble at the Hague. His promises and his threats were, however, now disregarded; and the states who, in contempt of his authority had assembled at Dordrecht, openly espoused the cause of their country, declared the prince of Orange commander of the national forces, and raised a considerable sum for the payment of his troops.

The prince's forces now amounted to 15,000 foot and 7000 horse, with which he advanced into Brabant, and took Ruremond by assault. He then possessed himself of Mechlin, Oudenarde, and Dendermonde, and having levied contributions on those inhabitants who adhered to the government, he marched towards Mons then besieged by the duke of Alva, with an intention to raise the siege, by bringing the duke to a general action. This, however, Alva declined, and Mons was obliged to capitulate.

17
Reverses.

In the midst of these succeses, a damp was thrown over the ardour of the patriots, by the news of the horrid massacre of St Bartholomew *, and in the same degree the spirit of the Spaniards revived. The prince of Orange found himself obliged to retire to the province of Holland, leaving the cities which he had taken at the mercy of the army. Mechlin opened its gates, and was pillaged without mercy, while the other towns were evacuated by the garrison, and loaded with heavy impositions. In a short time nothing remained to the patriots, but the provinces of Holland and Zealand; but these stood firm in the cause of liberty, and soon became the seat of a sanguinary warfare. Frederick de Toledo was detached by the duke of Alva to reduce the insurgents in these quarters. He quickly reduced Waerden, where his soldiers committed the most horrid acts of barbarity. The capture of this place was followed by that of Haerlem after an obstinate resistance.

* See France, N° 142.

18
Naval victories of the Zealanders.

To balance this ill success by land, however, the Zealanders obtained many important advantages by sea. They attacked the harbour of Antwerp, and carried off several ships; and when the governor equipped a squadron to oppose them, it was thrice encountered by Wertz, the Zealand admiral, and totally defeated. In the mean time the Spanish forces, under Frederick of Toledo, consisting of 16,000 veterans, sat down before Alkmaer, the capital of Holland, a town without regular fortifications, and defended only by 300 burghers and 800 soldiers, in great want of provisions, and without any prospect of speedy relief; yet this place, though attacked with great vigour, by a battery of 20 pieces of heavy cannon, which effected a breach in one of the walls, held out against every attempt, and the Spanish soldiers who attempted to storm the place by the breach, were repulsed with great slaughter, and Frederick was at length compelled to raise the siege.

19
Heroic defence of Alkmaer.

Notwithstanding these partial successes, the affairs of the patriots were still in a precarious situation. Don Louis de Requesnes, who had succeeded the duke of Alva in the government, was directed to carry on the war with the utmost vigour. The prince of Orange had, after a long siege, made himself master of Middleburgh, but had sustained a great loss by the defeat and death of his brother Louis. The patriotic cause derived some advantage, however, from a mutiny which took place in the Spanish army, but this advantage was of a transient nature.

20
The States apply for assistance to Elizabeth of England.
An. 1575.

In the commencement of the year 1575, an attempt at negociation took place between the contending parties, but they could come to no terms of accommodation, and the war was continued with great virulence. Though much distressed in his finances, Philip made extraordinary efforts to crush the patriots, and succeeded so far, that they almost despaired of ultimate success. In this dilemma they sent a deputation to Queen Elizabeth of England, offering to become her subjects, if she

would

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would afford them her protection; but from political reasons she declined the offer. The distresses which Philip now experienced, and the death of his deputy Requesnes, did more for the cause of the patriots than all their own exertions.

Profiting by those events, in the latter end of this year they attacked and carried the citadel of Ghent; while the inhabitants of Antwerp, in revenge for having been pillaged by the Spanish garrison that held the citadel, united in the common cause, by what was called the pacification of Ghent.

21 who at length sends them a supply of money. An. 1576.

A second application to Queen Elizabeth met with more success, and she advanced them the sum of 20,000l. sterling, on condition that they would not invite the French into their territories, that they would listen to any reasonable terms of accommodation, and repay the loan in the course of the ensuing year. Agreeably to these conditions, a cessation of hostilities was granted to the states by Don John of Austria, the present governor, and a treaty was entered into with him for disbanding the foreign troops. The weak state of the government required some concessions, and Don John acceded to the pacification of Ghent, by which most of the demands of the patriots were granted. The provinces of Holland and Zealand, however, conceiving that by this treaty the other provinces had conceded too much, refused their concurrence, and hostilities soon recommenced.

22 The war renewed with fresh vigour. An. 1578.

The king of Spain dissatisfied with the concessions of Don John, recalled that governor, and appointed the archduke Matthias in his room, while he made additional preparations for a vigorous prosecution of the war. The states-general in their turn made another application to Queen Elizabeth, and obtained from her, not only a promise of 100,000l. sterling, but of a body of forces consisting of 5000 foot, and 1000 horse; in return for which, the states agreed to put into her possession certain fortified towns, and to transport and pay the forces. These supplies, however, Elizabeth afterwards declined sending, though she professed all possible good will towards the provinces and their cause. A change of measures which about this time took place in the states of Guelderland and Groningen, in favour of the protestant interest, contributed not a little to aid the general cause of the patriots, though several of the provinces were still torn by intestine dissensions and jarring interests. At last the prince of Orange, perceiving that little confidence was to be placed in the unanimity of provinces rent by faction, different in religion, and divided by ambition, political maxims, and private interest, formed the scheme of more closely uniting the provinces of which he was governor, and cementing them with those more contiguous, in which the protestant interest prevailed. Such an alliance was subject to fewer difficulties than attended the more general one of uniting all the provinces; it was in fact the only measure that could be proposed with safety, and it was prosecuted with that alacrity and address for which William was deservedly celebrated.

23 Union of Utrecht. An. 1579.

On the 23d of January 1579, deputies from the provinces of Holland, Zealand, Utrecht, Friesland, Groningen, Overyssel, and Guelderland, met at Utrecht, and signed the alliance ever since known by the name of the *Union of Utrecht*, the basis of that commonwealth so renowned by the appellation of the *United Provinces*. This treaty of alliance was founded on the infraction of the pacification of Ghent solemnly acceded to by Philip, and the late invasion of certain towns in Guelderland. It was not hereby intended to divide the seven provinces from the other ten, or to renounce the pacification of Ghent; its object was to preserve the liberty stipulated in that pacification, by more vigorous operations, and united councils. The chief articles of this union were the following.

That the seven provinces shall unite themselves in interest as one province, never to be separated or divided by testament, donation, exchange, sale, or agreement; reserving to each particular province and city all its privileges, rights, customs, and statutes. In all disputes arising between either of the provinces, the rest shall interpose only as mediators. They shall assist each other with life and fortune against every foreign attempt upon any particular province, whether to establish sovereignty, the Catholic religion, arbitrary measures, or whatever else may appear inconsistent with the liberties of the province, and the intention of the alliance. All frontier towns belonging to the United Provinces shall, if old, be fortified at the expence of the provinces; if new, at the joint expence of the union. That the public imposts and duties shall be farmed for three months to the highest bidder, and employed with the king's taxes in the public service. No province, city, or member of the union, shall contract an alliance with any foreign prince or power, without the concurrence of all the other members. That foreign powers shall be admitted into the alliance, only by consent of all the contracting parties. As to religion, the provinces of Holland and Zealand shall act in that particular as they think advisable: the rest shall adhere to the purport of the edict published by the archduke Matthias, which prescribed, that no man should be oppressed on account of conscience. All the inhabitants from the age of 18 to 60, shall be trained and disciplined to war. That peace and war shall be declared by the unanimous voice of all the provinces; other matters that concern the internal policy shall be regulated by a majority. That the states shall be held in the usual constitutional manner, and coinage shall be deferred to future determination. Finally, the parties agree, that the interpretation of these articles shall remain in the states-general; but in case of their failing to decide, in the stadtholder.

24 Heroic behaviour of the prince of Orange.

Soon after the union of Utrecht, King Philip did all in his power to detach the prince of Orange from the new confederation. He offered to restore him to all his estates, to indemnify him for all his losses, and give him the first place in his esteem and favour; but William was too wise to rely on the promises of a prince who had already shewn himself perfidious, and too generous to abandon a cause in which he had embarked from no interested motives. He determined to share the fate of the United Provinces, and not to disappoint the hopes which they had conceived of his conduct.

25 Successes of the duke of Parma against the United Provinces.

In the mean time the duke of Parma was doing his utmost to disconcert the projects of the prince of Orange, and to reduce the provinces to their obedience to Spain. He besieged and took the town of Marsien; invested Maestricht, and carried it after a siege of four months, and reduced the republican general La Noue to such straits, that he was glad to retreat under the cannon of Antwerp. At length the Provinces, by the advice of the prince of Orange, resolved to solicit the assistance

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assistance and protection of the duke of Anjou, to whom they had formerly applied in vain, and to offer him the sovereignty of their territories. Accordingly, in 1580, they solemnly renounced their allegiance to Philip, and acknowledged as their sovereign, Francis Hercules de Vallois, duke of Alençon and Anjou; and in the following year they published an edict, entitled the abdication of Philip king of Spain, for ever excluding that monarch from any right or authority over the Netherlands.

26
Inauguration of the duke of Anjou as duke of Brabant.
An. 1582.

In the beginning of the year 1582, the duke of Anjou, who had already taken an active part in favour of his new subjects, and had opposed the duke of Parma with some success, arrived in Holland from England; and in the month of February he was solemnly installed at Antwerp as duke of Brabant. It appears, however, that the prince of Orange, though he had been the great promoter of this measure, and even placed the ducal coronet on the head of the new sovereign, still possessed the greatest influence and authority in the United Provinces.

27
Assassination of the prince of Orange.
An. 1584.

When Philip of Spain found that he could not bribe the prince of Orange to his interest, he resolved to use every method to rid himself of so dangerous an opponent. Soon after the signing of the union of Utrecht, Philip had proscribed the prince, and offered a reward of 25,000 crowns to any person that should bring him dead or alive to Madrid. The greatness of the reward, and a bigotted regard for the interests of the Catholic religion, prompted several to attempt murdering the prince of Orange. He narrowly escaped assassination in 1582; but, two years after he met his unmerited fate at Delft, by the hands of one Guion, or, as he is commonly called, Balthazar Gerrard. About the same time the duke of Anjou died in France; and the provinces of Holland and Zealand appointed Maurice, son of the late prince of Orange, to be their stadtholder and captain general. For an account of the actions of this great man, see the article *Maurice of Nassau*.

28
A truce for twelve years concluded with Spain.
An. 1609.

Philip II. died in 1598, and Philip III. prosecuted the war with the United Provinces with as much rancour as his predecessors, but with much worse success. The great defeat sustained by the archduke Albert in 1600, and many subsequent disasters, induced the court of Madrid at length to listen to terms of accommodation. In 1607 a suspension of hostilities took place, and the year following a treaty on terms favourable to the Provinces was concluded for 12 years.

29
Renewal of hostilities.
An. 1621.

At the expiration of the truce, both parties prepared for a renewal of hostilities; but now the Spaniards fought with considerable disadvantage: From a strange policy, which they have since frequently practised, in their contests with the powers of Europe, the Dutch contrived to advance their commercial interests at the expence of their enemy. A very lucrative trade took place between the principal Dutch ports and those of Spain, by which the Spaniards were supplied by their enemies even with ammunition and warlike stores. At the same time the Dutch enriched themselves by numerous prizes taken from the Spaniards, and, in particular gave a severe blow to the resources of the court of Madrid, by capturing the flota from Mexico, a prize valued at 15,000,000 of livres.

30
Conclusion of peace.
An. 1648.

These repeated losses of the Spaniards proved the inutility of their continuing the war against a people so determined as the Dutch. Accordingly, in 1648, they agreed to a treaty of peace, by which his Catholic majesty renounced all right and sovereignty over the states-general of the United Provinces; and these provinces were henceforth declared a free and independent republic. It was also agreed between the contending powers, that each should remain in unmolested possession of those places which they severally held at the signing of the treaty.

31
Flourishing state of the republic.

From this time to the year 1670 we meet with nothing very remarkable in the history of the United Provinces. By invariably pursuing the maxims of prudence, industry, and frugality, the republic had attained the highest pitch of grandeur. Amsterdam was become the emporium of Europe, and the richest city in the universe. The population of the provinces, especially of Holland, was much greater than at any former or subsequent period, though it is scarcely credible that, as some authors affirm, Holland alone should then contain 3,000,000 of inhabitants. The states dispatched ministers and consuls to China, Siam, and Bengal; to the Great Mogul, the king of Persia, and the khan of Tartary, the grand signior, the czar of Russia, and the princes of Africa. They were considered as an important weight in the scale of Europe; and no treaty was concluded without the concurrence of their ambassadors.

32
Dispute with France.
An. 1672.

It is not surprising that the successes of the Dutch, and the prosperous condition in which they now beheld themselves, should have rendered them rather arrogant towards the neighbouring states. Louis XIV. of France had conceived himself affronted by a foolish boast of one of the Dutch ministers, and he was particularly jealous of the advantage which the new republic had acquired over his subjects in the trade to India. The triple alliance formed about this time between England, Sweden, and the United Provinces, was an additional motive with the French king to break of all intercourse with the Dutch, and to curb their growing power. He began by prevailing on Charles II. of England to abandon the triple alliance; a request to which that worthless monarch, alive to nothing but his pleasures and his avarice, readily agreed, on condition of being well paid for his treachery. Louis also persuaded several of the German princes to unite their forces with his against the republic; and of all the Germanic body, only the elector of Brandenburg interested himself for the safety of the states-general. The French king assembled an army of 100,000 men, which he divided into four columns, one commanded by himself in person, with the assistance of Marshal Turenne; another by the prince of Condé; a third by General Crequi, and a fourth under the conduct of the duke of Luxemburg. Such an army drawing towards the frontiers could not but terrify the Dutch, now torn with civil and religious factions. The partisans of the Orange family were for abolishing the perpetual edict, and raising William prince of Orange to the dignity enjoyed by his predecessors; but the De Witt faction opposed him violently though they could not prevent the young prince from being chosen captain-general and high-admiral. Many hoped that William's new dignity would incline his uncle Charles II. to return to the triple alliance; but that hope was frustrated by the conduct of his majesty, who, in conjunction with the most Christian king, declared

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clared war against the states-general on the 7th of April. A month after, the elector of Cologne and bishop of Munster followed the example of the two kings. The Dutch put themselves in the best posture of defence that circumstances would admit. Maeastricht was strongly garrisoned; the prince of Orange had assembled an army of 25,000 men, with which he advanced to the banks of the Yssel; and the Dutch fleet cruised off the mouth of the Thames, to prevent the junction of the naval forces of England and France, which amounted to 150 ships. All Europe watched the first motions of the two powerful kings, seconded by the best generals of the age.

33 Commencement of hostilities.

Holland could be attacked only by the Rhine or the Meuse, and the French generals and ministers differed by which of these inlets the first impression should be made. At length, after much deliberation, it was determined to attack the Dutch on both these sides at the same time, in order the more to disconcert their councils. The campaign began with the siege of Rhinberg, Vesel, Orsoi, and Rurick, four towns well fortified, and deemed the keys of Holland. Nothing could oppose armies so well appointed, led by generals so skilful and so experienced. The four towns were compelled to surrender within a few days of each other; and a severe defeat sustained by a body of Dutch troops, in attempting to defend the passage of the Rhine, by the prince of Condé, served still more to dishearten the troops of the states-general.

34 Rapid successes of the French.

It is almost incredible with what rapidity towns and fortresses yielded to the fortune of his majesty's arms. The reduction of Betau, the most fruitful country of the United Provinces, and the surrender of Tolhusfert, obliged the prince of Orange to abandon the Yssel, lest he should be attacked in the rear, and to retire to the very heart of the country, as far as Rhenen in the province of Utrecht. By this means the town of Arnheim, the forts of Knotsemborough, Voorn, St André, and Shenck, this last the strongest in the Netherlands, with a variety of other forts and towns, surrendered as soon as summoned; and at last Nimeguen, a town strong from the nature of the works and fortifications, and garrisoned by 8000 fighting men, including the inhabitants, was invested. After the citizens had for eight days exhibited signal proofs of courage in defence of their liberties, they were forced to yield to the superior skill of Turenne.

35 The Dutch compelled to inundate their country. An. 1672.

The only means by which the Dutch could arrest the progress of the enemy was, to open the sluices and inundate the country. The town of Utrecht set the example, which was soon followed by many others, and in a short time Holland, Brabant, and Dutch Flanders, formed one vast lake, the towns rising like islands in the midst of the waters. An embassy was also sent to the king of England, to request that he would prevail on Louis to relax in the severity of his attack. Charles pretended a compliance with this request; but as his interference produced no effect, it is probable that he was not sincere. In the space of three months, Louis conquered the provinces of Guelderland, Overyssel, and Utrecht, took about 50 towns and forts, and made 24,000 prisoners. The latter, however, were soon released for a trifling ransom. The very successes of the conquerors tended to weaken their force, as they were compelled to leave behind them several strong bodies of troops, to garrison the captured towns. This induced the French to listen to proposals for a negociation, which, however, came to nothing.

Marshal Turenne, now appointed generalissimo of the king's army on his majesty's return to Paris, marched to oppose the elector of Brandenburg and the German general Montecuculi, who had joined their forces, and were about to pass the Rhine. For three whole months were the elector and Montecuculi employed in abortive attempts to effect a passage at Mentz, Coblentz, Strasburg, and other places. This answered the purpose of making a powerful diversion in favour of the Dutch, though they could not accomplish their design of joining the prince of Orange. After repeated disappointments, the imperial army directed its march to Westphalia; and Turenne followed, in order to keep the bishop of Munster steady to his engagements. For half the campaign he, with a body of 16,000 men, baffled every stratagem of the elector and Montecuculi, the latter the most renowned general of the empire, at the head of an army near triple his strength. He obliged them to go into winter quarters, in a country harassed and exhausted; and confirmed the bishop of Munster in the alliance of France, at the very time he was on terms with the emperor. He obliged the elector of Brandenburg, who took the chief command during Montecuculi's illness, to abandon the siege of Warle, took Unma Kamen, Altena, Berkemham, and several other towns and fortresses. By continuing his operations, he forced the elector out of his winter quarters again into the field, chased him from post to post, until he obliged him to quit Westphalia, repass the Weser, and retire with precipitation into the bishopric of Hildersheim. After taking possession of the elector's towns in Westphalia, he pursued him into the bishopric of Hildersheim, and at length, by mere dint of superior genius, forced him to seek shelter in his hereditary dominions. All this was effected after Louvois had appointed the marshal's army quarters in Alsace and Lorrain, amidst the rigours of a severe winter, opposed by a superior enemy, by the artifices of Louvois, and seconded only by his own prudence, and the affection of his troops, which he maintained in defiance of all the difficulties, hardships and dangers, they encountered. It was indeed supposed, that Montecuculi was prevented from giving Turenne battle by the remonstrances of Prince Lobkovitz, the emperor's ambassador, influenced by the gold of Louis. Certain indeed it is, that Montecuculi's illness arose from his chagrin at seeing all his projects frustrated by the unsteady dilatory conduct of the court of Vienna. Louis's negociations disturbed Europe no less than his arms. His tools and creatures swarmed in every court. Leopold could not be prevented from declaring in favour of Holland; but his ministers were bought off from seconding the emperor's intentions. The whole English nation exclaimed against the alliance of their kingdom with France; but Charles stood in need of French gold to supply his extravagance and profligacy. The elector of Bavaria had indeed been compelled by Louis to retire to his capital; but it was by dint of intrigue that he was forced from his alliance with Holland, and constrained to make a peace with France.

While the French generals were thus carrying all before them, the combined fleets of France and England were

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were scarcely less successful against the maritime power of the Dutch. The English squadron under the duke

36 Transactions of the Dutch at sea.

of York, uniting to that of France under D'Estrees, thrice engaged the Dutch fleet commanded by De Ruyter; and though neither party could boast of much advantage, the check sustained by the Dutch admiral was of essential service to the cause of the allies.

37 Change of fortune,

At length the tide of fortune began to turn in favour of the United Provinces. The court of Spain, jealous of the growing power of France, embraced the cause of the Dutch; and sent an army of 10,000 men to the assistance of the prince of Orange, while the mercenary king of England was compelled by his parliament to withdraw from his unnatural alliance with the French king; and the late ill success among the allied troops of France and Germany cooled the elector of Cologne and the bishop of Munster, in their friendship towards Louis. Thus that monarch, forsaken by his allies, was compelled to maintain singly a war against the empire, Spain, and the United Provinces. The accession of the prince of Orange to the throne of England, in 1688, gave an additional blow to the French power, by bringing on an intimate connection between England and Holland.

38 and consequent peace with France. An. 1697.

At length Louis was compelled to negociate for peace, which was concluded in 1697, by a treaty extremely favourable to the United Provinces.

39 Summary of the Dutch affairs from the end of the 17th to the beginning of the 19th century.

After the death of William III. the same plan of humbling the French king, was, in conjunction with the states-general, pursued by his successor Queen Anne; and the numerous and important victories of the duke of Marlborough and Prince Eugene, led to the famous treaty of Utrecht, in 1713. See Britain, N° 340—371. In 1747, the office of stadtholder was declared hereditary in the princes of Orange. In the war that took place in 1756, between France and England, a French party was formed in Holland, in opposition to the stadtholder, who favoured the alliance with England. Hence arose a jealousy between the two allies, which, during the American war, increased to an open rupture. See Britain, N° 427, and N° 598, *et seq.* In 1787, some disputes took place between the stadtholder and the states-general, which induced the former to require the assistance of the king of Prussia. That monarch accordingly sent an army of 18,000 Prussians to Amsterdam, under the duke of Brunswick, who, in 1788, brought the whole country into subjection, and reinstated the stadtholder in his authority. See Prussia, N° 73. In 1794 the republican armies of France having overrun the greater part of Flanders, took possession of the Dutch provinces, which they converted into the Batavian republic. The stadtholder found refuge in England, and the allied armies of Germany and Prussia retreated into Germany. See France, N° 409, et seq. In the summer of 1799, a considerable British force landed in the Texel island, made themselves masters of the Dutch fleet, and, in conjunction with a body of Russians, gained some advantages on the continent. Being opposed, however, by a superior French force, the army was obliged to reimbark, and return to England. See Britain, N° 1069. By the treaty of Amiens, concluded in March 1802, all the colonies taken by the British were restored to Holland, except the island of Ceylon. On the renewal of hostilities in 1803, the Batavian republic was again compelled to take an active part against Britain, and in consequence again lost the Cape of Good Hope, and several other colonies, besides having her trade entirely ruined. Soon after the imperial diadem of France was conferred on Napoleon Bonaparte, his brother, Louis, was appointed king of Holland. Louis, however, proved to be a man not calculated to serve his brother's purposes. He was considerate and humane, paid great attention to the complaints of his subjects, employed none but Dutchmen in his government, and continually exerted his influence to soften the harsh measures of which he was compelled to be the instrument. The nation was sensible of his good services, and Louis was highly popular. But in the same proportion as he gained the confidence of the nation, he lost that of Napoleon; who at length determined on setting him aside. Louis learned what was intended, and escaped the humiliation of being deposed, by resigning the crown to his infant son on the first of July 1810. On the 9th July, Napoleon issued a decree, annexing the United Provinces to the French empire. From this period Holland followed the fortunes of France, till the battle of Leipsic shattered the French power. On the 15th November, 1813, one month after the battle of Leipsic, a simultaneous rising took place in all the most considerable towns. The French garrisons were feeble and soon mastered; and on the 21st November, a deputation arrived in London to invite the prince of Orange to return, who accordingly arrived there on the 30th, and obtained immediate possession of the government. By the treaty of Paris, 30th May 1814, the ten provinces of the Netherlands were united to Holland, and the prince of Orange took the title of king of the Netherlands. This plan of union was not favourably received on either side, there being an ancient grudge between the two countries, which was strengthened by commercial jealousy, and by difference of religion, the Dutch being chiefly of the reformed church, and the Belgians catholics. The population of both countries in 1818 was 5,266,000.

40 Population of the United Provinces.

According to the statistical table given in N° 2, the population of the United Provinces in the year 1796, appears to amount to 1,880,469 individuals; but this enumeration being made while the French had possession of the country, was believed to be under the truth. By returns made to the government in 1818, the population amounted to 2,016,159.

41 Constitution and government.

In the late republic of Holland, previous to the French revolution, the states-general formed the great council of the nation. That assembly was formed by deputies from the provincial states, and was invested with the supreme legislative power. It could not, however, make peace or war, form new alliances, or levy taxes, without the consent of the provincial states, nor could these determine any point of importance, without the consent of each of the cities that had a voice in their assembly. The stadtholder exercised a considerable part of the executive power, though in later times his power became very limited. The grand pensionary was properly a minister of the province; and though he possessed great influence, being a perpetual member of the states-general, and of the secret committee, he was considered as inferior in rank to all the deputies.

42 Revenues.

The revenues of the United Provinces arose principally from taxes imposed on each province and city, according

cording to their ability. These consisted chiefly of a general excise, a land-tax, a poll-tax, and hearth money; and are supposed to have amounted to 3,000,000l. sterling.

43 Military strength.

Before the French revolution, the Dutch maintained a peace establishment of 30,000 men, which in war was augmented to above 50,000, chiefly by mercenary troops from Germany. Their naval establishment was highly respectable; and at the end of the 17th century it exceeded that of any other maritime power in Europe. Before the late war they could muster 40 sail of the line, 40 frigates, and 10 cutters. Since the celebrated engagement off the Dogger Bank during the American war, the Dutch have been scarcely able to cope with the English at sea; and the victory off Camperdown in October 1797, with the subsequent loss of the Texel fleet in 1799, proved the deathblow to the naval power of Holland.

44 Religion.

Before the late change of government, the established religion of Holland was Presbyterianism, according to the doctrines of Calvin; though all sects of Christians were tolerated. The church was governed by consistories, classes, and synods, from which there was an appeal to one great national synod, subject to the controul of the states-general.

45 Language and literature.

The Dutch language is a dialect of the German, and in many respects bears a considerable resemblance to the Old English and Lowland Scotch. The literature of the United Provinces has long been respectable; and the universities of Leyden, Utrecht, Groningen, Harderwyck, and Franeker, have produced many eminent and celebrated men in almost every department of science. Grotius, Erasmus, Boerhaave, Leuwenhoeck, Swammerdam, Grævius, Burrman, Hooguween, &c. are names mentioned with admiration and respect in the annals of literature.

46 Manufactures.

The Dutch manufactures consist principally of fine linens, earthen ware, chiefly manufactured at Delft, especially white and painted tyles, tobacco-pipes, borax, oil, starch, paper, leather, woollen and cotton cloths, snuff, tobacco, and gin.

47 Commerce.

The commerce of the Dutch was formerly more extensive than that of any other country in Europe. They carried on a trade with every quarter of the globe, and in particular their East India Company was perhaps the richest society of merchants in the world. Holland was almost the exclusive centre of the spice trade; and the extensive fisheries on the coast of Greenland and in the North sea, supplied the greater part of Europe with whale oil and herrings. Besides this external commerce, they carried on a considerable inland traffic with the interior of Germany, from which they brought immense quantities of timber. Vast rafts of trees, many hundred feet in length, set out annually from the forests of Andernach, and other places on the Rhine, and proceeding down the river under the direction of a great body of labourers, that formed a village of huts on the surface of the raft, sailed down the Rhine and the Waal to Dort, where the timber was disposed of, and where one raft has been sold for 30,000l. sterling. All the foreign trade of Holland may now be considered as annihilated, but the inland traffic in wood and spirits still continues.

The inland commerce of the United Provinces is greatly promoted by the facility of conveyance from one part of the country to another, by means of the numerous canals.

48 Character of the Dutch.

The Dutch are, by constitution, a cool, or rather phlegmatic people, laborious, patient, obstinate, and persevering. When stimulated by any predominant passion, as avarice, or formerly love of liberty, they are capable of great exertions. Economy and order in the management of their pecuniary concerns are common among all classes, with whom it is an established maxim to spend less than their income. Interest and love of money regulate all their actions, and appear to supplant in their breasts every noble and generous feeling. These prominent features in the national character are, of course, modified by the rank or situation of the different orders in society. The higher ranks value themselves much on their distinctions, are reserved to strangers, but affable and obliging to those with whom they have had an opportunity of becoming acquainted; friendly, candid, and sincere. The mercantile men and traders are, in general, fair and honest in their transactions; though their natural thirst of gain sometimes tempts them to deceive and overreach their customers. The lower ranks are ignorant, dull, and slow of apprehension, but open to conviction, and patient of fatigue and labour.

49 Manners and customs.

Dress, among the Dutch, is regulated less by fashion, then by an attention to climate and season. The moisture and inconstancy of these require a greater quantity of clothing than is found necessary in other countries under the same latitude; and, among the ordinary classes, bread hats, large breeches, and thick boots and shoes, are still almost universal. Most of the women wear hats with low crowns and very broad rims, with jerkins and short petticoats; and, what appears exceedingly ridiculous to strangers, the boys and girls wear the same dress as the men and women.

A close attention to regularity and neatness in the streets and the interior of the houses prevails throughout the United Provinces, but is most conspicuous in North Holland. This was at first rendered necessary by the nature of the climate, to prevent rust and mouldiness from destroying their utensils and furniture, and has since become a habit, conducive at once to comfort and to health. The manner of living in Holland was, till of late, not a little gross. Their diet consisted much of high-seasoned and salted meats, butter, cheese, and spirituous liquors. In no country was gormandizing reduced more to a system. Convivial entertainments were extremely frequent; and the interval between the more substantial meals of dinner, tea, and supper, were filled up with cakes, fruits, jellies, and other light things; not to mention smoking and drinking, which supplied the place of conversation (c). If we may rely on the report of a late writer on the statistics of Holland*, the style of living is now much changed, though not much improved

* *Metelerkamp. Sea Month. Mag. for Nov. 1807.*

(c) We must admit, that, in so moist and cold a climate, a full and generous diet may be safe if not necessary; but the Dutch, like many of our own countrymen, absurdly carried the same system into their tropical colonies.

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improved. Animal food is become extremely rare, and its place is supplied by a greater proportion of gin, tea, and coffee. The prevailing amusements in winter are dramatic entertainments and skaiting, in which latter they are exceedingly expert.

The Dutch taste for formal gardens, straight walks, trees and hedges clipped into fantastic shapes, and flower roots, has long been proverbial, and has been treated with more contempt and ridicule than it deserves. At worst, these are but harmless propensities; and, if indulged in moderation, are well suited to relieve the sameness and inactivity of a retirement from the busy scenes of trade and commerce.

UNITY, in *Poetry*. There are three unities to be observed, viz. the unity of action, that of time, and that of place. In the epic poem, the great and almost the only, unity, is that of the action. Some regard indeed ought to be had to that of time; for that of place there is no room. The unity of character is not reckoned among the unities. See POETRY, Part II. Sect. 3.

UNIVERSAL, something that is common to many things; or it is one thing belonging to many or all things.

UNIVERSE, a collective name, signifying the whole world; or the assemblage of heaven and earth, with all things therein. See ASTRONOMY and GEOGRAPHY.

UNIVERSITY, is the name of a corporation formed for the education of youth in the liberal arts and sciences, and authorised to admit such as have studied in it, to certain *degrees* in different faculties, which not only serve as certificates of proficiency in science, but also confer on those who obtain them considerable privileges within the university, as well as some rank in the state without it. Universities generally comprehend within them one or more colleges; but this is not always the case; for the university of St Andrew's was in being before either of its colleges was founded, and it would continue in being, with all its privileges, though both its colleges were levelled with the dust.

In every university with which we are acquainted, there are four faculties, viz. *Theology*, *Law*, *Physic*, and the *Arts and Sciences*, comprehending mathematics, natural and moral philosophy, &c.: and in Oxford, Cambridge, and some other universities, *Music* is considered as a fifth faculty. In each of these there are two degrees, those of *Bachelor* and *Doctor*; for though in the universities of Great Britain and Ireland we have no such degree as *Doctor in Arts and Sciences*, our *Master of Arts*, answers to the degree of *Doctor in Philosophy*, which is conferred by many of the universities on the continent.

Universities in their present form, and with their present privileges, are institutions comparatively modern. They sprang from the convents of regular clergy, or from the chapters of cathedrals in the church of Rome, where young men were educated for holy orders, in that dark period when the clergy possessed all the little erudition which was left in Europe. These convents were seminaries of learning probably from their first institution; and we know with certainty, that in Old Aberdeen there was a monastery in which youth were instructed in *theology*, the *canon law*, and the *school philosophy*, at least 200 years before the university and King's College were founded. The same was doubtless the case in Oxford and Cambridge, and probably in every town in Europe, where there is now a university which has any claim to be called ancient; for it was not till the more eminent of the laity began to see the importance of literature and science, that universities distinct from convents were founded, with the privilege of admitting to degrees, which conferred some rank in civil society. These universities have long been considered as lay corporations; but as a proof that they had the ecclesiastical origin which we have assigned to them, it will be sufficient to observe, that the pope arrogated to himself the right of vesting them with all their privileges; and that, prior to the Reformation, every university in Europe conferred its degrees in all the faculties by authority derived from a papal bull.

It is perhaps no improbable conjecture, that the church of Rome derived her idea of academical honours from the Jews, among whom literary distinctions extremely similar subsisted before the nativity of our Saviour. Among them, the young student, with respect to his learning, was called a *disciple*; from his minority a *junior*; and the *chosen* or *elected*, on account of his election into the number of disciples. When he had made some progress in knowledge, and was deemed worthy of a degree, he was by imposition of hands made חבר, *a companion* to *a Rabbi*, the person who officiates using this form, *I associate thee*, or, *Be thou associated*; and as soon afterwards as he was thought worthy to teach others, the *associate* was raised to the rank of *Rabbi*. Whether this process suggested the idea or not, it has certainly some resemblance to that by which a young man in our universities passes through the degree of *Bachelor* to that of *Master of Arts*, or *Doctor*.

The most ancient universities in Europe are those of OXFORD, CAMBRIDGE, PARIS, SALAMANCA, and BOLOGNA; and, in the two English universities, the first colleges are those of *University*, *Baliol*, and *Merton*, in the former, and *St Peter's* in the latter. Oxford and Cambridge, however, were universities, or, as they were then called, *studies*, some hundreds of years before colleges or schools were built in them; for the former flourished as a seminary of learning in the reign of Alfred the Great, and the other, could we believe its partial partizans, at a period still earlier. The universities of Scotland are four, ST ANDREWS, GLASGOW, ABERDEEN, and EDINBURGH. In Ireland there is but one university, viz. that of DUBLIN, founded by Queen Elizabeth, and very richly endowed.

An idle controversy has been agitated, whether the constitution of the English or of the Scotch universities be best adapted to answer the ends of their institution; and, as might be expected, it has been differently decided, according to the partialities of those who have written on the subject. Were we to hazard our own opinion, we should say, that each has its advantages and disadvantages; and that while the English universities, aided

The account given by a late traveller (see Barrow's *Voyage to Cochin-China*) of the luxurious mode of living at Batavia, affords a melancholy, but accurate picture of Dutch gluttony.

aided by their great schools, to which we have nothing that can be compared, are unquestionably fitted to carry their young members farthest in the knowledge of the learned languages, the mode of teaching in our own universities is better adapted to the promotion of arts and sciences, and the communication of that knowledge which is of most importance in active life.

UNIVERSITY-Courts, in England. The two universities enjoy the sole jurisdiction, in exclusion of the king's courts, over all civil actions and suits whatsoever, where a scholar or privileged person is one of the parties; excepting in such cases where the right of freehold is concerned. And then by the university charter they are at liberty to try and determine, either according to the common law of the land, or according to their own local customs, at their discretion; which has generally led them to carry on their process in a course much conformed to the civil law.

This privilege, so far as it relates to civil causes, is exercised at Oxford in the chancellor's court; the judge of which is the vice-chancellor, his deputy, or assessor. From his sentence an appeal lies to delegates appointed by the congregation; from thence to other delegates of the house of convocation; and if they all three concur in the same sentence, it is final, at least by the statutes of the university, according to the rule of the civil law. But if there be any discordance or variation in any of the three sentences, an appeal lies in the last resort to judges delegates appointed by the crown, under the great seal in chancery.

As to the jurisdiction of the university courts in criminal matters, the chancellor's court at Oxford, and probably also that of Cambridge, hath authority to try all offences or misdemeanors under the degree of treason, felony, or mayhem; and the trial of treason, felony, and mayhem, by a particular charter, is committed to the university jurisdiction in another court, namely, the court of the lord high steward of the university.

The process of the trial is this. The high steward issues one precept to the sheriff of the county, who thereupon returns a panel of 18 freeholders; and another precept to the bedells of the university, who thereupon return a panel of 18 matriculated laymen, *laicos privilegio universitatis gaudentes:* and by a jury formed *de medietate*, half of freeholders and half matriculated persons, is the indictment to be tried; and that in the guildhall of the city of Oxford. And if execution be necessary to be awarded in consequence of finding the party guilty, the sheriff of the county must execute the university process; to which he is annually bound by an oath.

VOCABULARY, in *Grammar*, denotes the collection of the words of a language, with their significations, otherwise called a *dictionary*, *lexicon*, or *nomenclature*. See DICTIONARY.

A vocabulary is properly a smaller kind of dictionary, which does not enter so minutely into the origin and different acceptations of words.

VOCAL, something that relates to the voice or speech; thus vocal music is that set to words, especially verses, and to be performed by the voice; in contradistinction to instrumental music, composed only for instruments, without singing.

VOCATIVE, in *Grammar*, the fifth state or case of nouns. See GRAMMAR.

VOETIUS or VOET, GISBERT, an eminent divine of the 16th century, was professor of divinity and the Oriental tongues at Utrecht, where he was also minister. He assisted at the synod of Dort; and died in 1676, aged 87. He wrote a great number of works; and was the declared enemy of Des Cartes and his philosophy. His followers are called *Voetians*. Voetius had two sons, *Daniel* and *Paul*, both authors. *John Voetius*, the son of Paul, was doctor and professor of law at Herborn, and wrote a commentary on the Pandects.

VOICE, a sound produced in the throat and mouth of an animal, by peculiar organs.

Voices are either articulate or inarticulate. Articulate voices are those whereof several conspire together to form some assemblage or little system of sounds: such are the voices expressing the letters of an alphabet, numbers of which joined together form words. Inarticulate voices are such as are not organized, or assembled into words; such is the barking of dogs, the braying of asses, the hissing of serpents, the singing of birds, &c.

For a description of the organs of the voice, see ANATOMY; see also PHYSIOLOGY *Index*.

VOICE, in *Grammar*, a circumstance in verbs, whereby they come to be considered as either active or passive, *i. e.* either expressing an action impressed on another subject, as *I beat;* or receiving it from another, as, *I am beaten*. See GRAMMAR.

VOICE, in matters of election, denotes a vote or suffrage.

VOICE, in *Oratory*. See DECLAMATION; READING, N° 5.; and ORATORY, N° 129—131.

VOLANT, in *Heraldry*, is when a bird, in a coat of arms, is drawn flying, or having its wings spread out.

VOLATILE, in *Physics*, something that is easily dissipated by fire or heat.

VOLATILE Alkali. See AMMONIA, CHEMISTRY *Index*.

VOLATILISATION, the art of rendering fixed bodies volatile, or of resolving them by fire into a vapour.

VOLCANO, a name given to burning mountains, or to vents for subterraneous fires. See GEOLOGY *Index*, ÆTNA, HECLA, &c.

VOLERY, a bird-cage, of such a size that the birds have room to fly up and down in it.

VOLGA, the largest river in Europe, derives its origin from two small lakes in the forest of Volkonski about 80 miles from Tver, a town in Russia. It is navigable a few miles above that town. This noble river waters some of the finest provinces in the Russian empire, and at last falls into the Caspian sea by several mouths, below Astracan.

The Volga is subject to annual inundations. In the year 1774, the inundations exceeded the lowest watermark by nearly 40 feet, since which period they have been rather on the decline; for in 1775, they rose only to 39 feet 2 inches above that mark; in 1782, they rose to 26 feet; in 1785, to 25 feet 2 inches; and in the year 1791, their height was the same. Pallas is of opinion that this phenomenon may have originated from the diminished quantity of snow and rain which had fallen in the higher countries; from the greater evaporation of the Caspian sea, and the gradual extension of the different mouths of the river, or perhaps from the joint operation of all these causes.

VOLITION,

Volition || Voltaire.

VOLITION, an act of willing. See METAPHYSICS.

VOLLEY, a military salute, made by discharging a great number of fire arms at the same time.

VOLONES, in Roman antiquity, slaves who in the Punic war voluntarily offered their service to the state, which is the reason of the appellation; upon which they were admitted to citizenship, as none but freemen could be soldiers.

VOLT, in the manege, a round or circular tread; and hence, by the phrase *to make volts*, is understood a gate of two treads, made by a horse going sidewise round a centre, in such a manner that these two treads make parallel tracks; one larger, made by the fore-feet, and another smaller, made by the hind-feet; the croup approaching towards the centre, and the shoulders bearing out.

VOLTAIRE, FRANCIS AROUET DE, a celebrated French author, was born at Paris, February 20. 1694. His father, Francis Arouet, was *ancien notaire au Chatelet*, and treasurer of the chamber of accounts; his mother, Mary-Margaret Draumart. At the birth of this extraordinary man, who lived to the age of 85 years and some months, there was little probability of his being reared, and for a considerable time he continued remarkably feeble. In his earliest years he displayed a ready wit and a sprightly imagination; and, as he said of himself, made verses before he was out of his cradle. He was educated under Father Poré, in the college of Louis the Great; and such was his proficiency, that many of his essays are now existing, which, though written when he was between 12 and 14, show no marks of infancy. The famous Ninon de l'Enclos, to whom this ingenious boy was introduced, left him a legacy of 2000 livres to buy him a library. Having been sent to the equity schools on his quitting college, he was so disgusted with the dryness of the law, that he devoted himself entirely to the muses. He was admitted into the company of the abbé Chaulieu, the marquis de la Fare, the duke de Sully, the grand prior of Vendôme, Marshal Villars, and the chevalier du Bouillon; and caught from them that easy taste and delicate humour which distinguished the court of Louis XIV. Voltaire had early imbibed a turn for satire; and, for some philippics against the government, was imprisoned almost a year in the Bastile. He had before this period produced the tragedy of *Oedipus*, which was represented in 1718 with great success; and the duke of Orleans happening to see it performed, was so delighted, that he obtained his release from prison. The poet waiting on the duke to return thanks; "Be wise (said the duke), and I will take care of you." "I am infinitely obliged (replied the young man); but I intreat your royal highness not to trouble yourself any farther about my lodging or board."

He began his *Henriade* before he was 18. Having one day read several cantos of this poem when on a visit to his intimate friend, the young president de Maisons, he was so teased with objections, that he lost patience, and threw his manuscript into the fire. The president Henaut with difficulty rescued it. "Remember (said Mr Henaut to him, in one of his letters) it was I that saved the Henriade, and that it cost me a handsome pair of ruffles." Some years after, several copies of this poem having got abroad, while it was only a sketch, an edition of it was published, with many chasms, under the title of *The League*. Instead of fame and friends, the author gained only enemies and mortification, by this first edition. The bigots took fire at it, and the poet was considered as highly criminal for praising Admiral Coligny and Queen Elizabeth. Endeavours were even used to get the piece suppressed; but this strange design proved abortive. His chagrin, on this occasion first inspired him with the thought of visiting England, in order to finish the work, and republish it in a land of liberty. He was right; for King George I. and more particularly the princess of Wales, afterwards queen of England, raised an immense subscription for him. Their liberality laid the foundation of his fortune; for on his return to France in 1728, he put his money into a lottery established by M. Desfortes, comptroller-general of the finances. The adventurers received a rent charge on the *Hotel-de-Ville* for their tickets; and the prizes were paid in ready money; so that if a society had taken all the tickets, it would have gained a million of livres. He joined with a numerous company of adventurers, and was fortunate.

His *Lettres Philosophiques*, abounding in bold expressions and indecent witticisms against religion, having been burnt by a decree of the parliament of Paris, and a warrant being issued for apprehending the author in 1733, Voltaire prudently withdrew; and was sheltered by the marchioness du Chatelet, in her castle of Cirey, on the borders of Champagne and Lorraine, who entered with him on the study of the system of Leibnitz, and the Principia of Newton. A gallery was built, in which Voltaire formed a good collection of natural history, and made an infinite number of experiments on light and electricity. He laboured in the mean time on his Elements of the Newtonian Philosophy, then totally unknown in France, and which the numerous admirers of Des Cartes were little desirous should be known. In the midst of these philosophic pursuits he produced the tragedy of *Alzira*. He was now in the meridian of his age and genius, as was evident from the tragedy of *Mahomet*, first acted in 1741; but it was represented to the procureur-general as a performance offensive to religion; and the author, by order of Cardinal Fleury, withdrew it from the stage. *Merope*, played two years after, 1743, gave an idea of a species of tragedy, of which few models had existed. It was at the representation of this tragedy, that the pit and boxes were clamorous for a sight of the author; yet it was severely criticised when it came from the press. He now became a favourite at court, through the interest of Madame d'Etiole, afterwards marchioness of Pompadour. He was appointed a gentleman of the bed-chamber in ordinary, and historiographer of France. He had frequently attempted to gain admittance into the Academy of Sciences, but could not obtain his wish till 1746, when he was the first who broke through the absurd custom of filling an inaugural speech with the fulsome adulation of Richelieu; an example soon followed by other academicians. From the satires occasioned by this innovation he felt so much uneasiness, that he was glad to retire with the marchioness du Chatelet to Luneville, in the neighbourhood of King Stanislaus. The marchioness dying in 1749, Voltaire returned to Paris, where his stay was but short. The king of Prussia now gave Voltaire an invitation to live with him, which he accepted towards the end of August

gust 1750. On his arrival at Berlin, he was immediately presented with the *Order of Merit*, the *key of chamberlain*, and a *pension* of 20,000 livres. From the particular respect that was paid to him, his time was now spent in the most agreeable manner; his apartments were under those of the king, whom he was allowed to visit at stated hours, to read with him the best works of either ancient or modern authors, and to assist his majesty in the literary productions by which he relieved the cares of government. But a dispute which arose between him and Maupertuis soon brought on his disgrace. Maupertuis was at some pains to have it reported at court, that one day while General Manstein happened to be in the apartments of M. de Voltaire, who was then translating into French the Memoirs of Russia, composed by that officer, the king, in his usual manner sent a copy of verses to be examined, when Voltaire said to Manstein, "Let us leave off for the present, my friend; you see the king has sent me his dirty linen to wash, I will wash yours another time." A single word is sometimes sufficient to ruin a man at court; Maupertuis imputed such a word to Voltaire, and succeeded. It was about this very time that Maupertuis published his very strange Philosophical Letters; and M. de Voltaire did not fail to heighten, with his utmost powers of raillery, every thing which he found, or could make ridiculous, in the projects of M. Maupertuis, who was careful to unite his own cause with that of the king; Voltaire was considered as having failed in respect to his majesty; and therefore, in the most respectful manner, he returned to the king his chamberlain's key, and the cross of his Order of Merit; accompanied with four lines of verse, in which he, with great delicacy, compares his situation to that of a jealous lover, who sends back the picture of his mistress. The king returned the key and the ribbon; but they were not followed by an immediate reconciliation. Voltaire set out to pay a visit to her highness the duchess of Gotha, who honoured him with her friendship as long as she lived. While he remained at Gotha, Maupertuis employed all his batteries against him: Voltaire was arrested by the king's orders, but afterwards released.

He now settled near Geneva; but afterward being obliged to quit that republic, he purchased the castle of Ferney in France, about a league from the lake of Geneva. It was here that he undertook the defence of the celebrated family of Calas; and it was not long before he had a second opportunity of vindicating the innocence of another condemned family of the name of *Sirven*. It is somewhat remarkable, that in the year 1774, he had the third time a singular opportunity of employing that same zeal which he had the good fortune to display in the fatal catastrophe of the families of Calas and Sirven.

In this retreat M. Voltaire continued long to enjoy the pleasures of a rural life, accompanied with the admiration of a vast number of wits and philosophers throughout all Europe. Wearied at length, however, with his situation, or yielding to the importunities of friends, he came to Paris about the beginning of the year 1778, where he wrote a new tragedy called *Irene*. By this time his understanding seems to have been impaired, either through the infirmities of age, or continued intoxication by the flattery of others; and he ridiculously suffered himself to be crowned in public with laurel, in testimony of his great poetical merit. He did not long survive this farce: for having overheated himself with receiving visits, and exhausted his spirits by supplying a perpetual fund of conversation, he was first seized with a spitting of blood; and at last becoming restless in the night-time, he was obliged to use a soporific medicine. Of this he unluckily one night took so large a dose, that he slept 36 hours, and expired a very short time after awakening from it.

VOLUME, in matters of literature, a book or writing of a just bulk to be bound by itself. The name is derived from the Latin *volvere*, "to roll up;" the ancient manner of making up books being in rolls of bark or parchment. See BOOK.

VOLUNTARY, in *Music*, a piece played by a musician extempore, according to his fancy. This is often used before he begins to set himself to play any particular composition to try the instrument, and to lead him into the key of the piece he intends to perform.

VOLUNTEERS, persons who, of their own accord, for the service of the prince or state, serve in the army without being enlisted, to gain honour and preferment.

VOLVOX, a genus of animals belonging to the *vermes infusoria*. See HELMINTHOLOGY *Index*.

VOLUSENUS. See WILSON.

VOLUTA, a genus of shell-fish. See CONCHOLOGY *Index*.

VOLUTE, in *Architecture*, a kind of spiral scroll used in Ionic and Composite capitals, whereof it makes the principal characteristic and ornament.

VOMICA, in *Medicine*, an abscess of the lungs. See MEDICINE, N° 186.

Nux Vomica, in *Pharmacy*. See MATERIA MEDICA *Index*.

VOMIT. See EMETIC, MATERIA MEDICA *Index*.

VOMITING, a retrograde spasmodic motion of the muscular fibres of the œsophagus, stomach and intestines, attended with strong convulsions of the muscles of the abdomen and diaphragm; which when gentle create a nausea, when violent a vomiting.

VOORN, one of the islands of Holland, lying at the mouth of the Maese, opposite to Rotterdam.

VORTEX, in *Meteorology*, a whirlwind, or sudden, rapid, and violent motion of the air in circles; or that motion of the water called an *eddy* or whirlpool.

VORTEX, in the Cartesian philosophy, is a system or collection of particles of matter moving the same way, and round the same axis.

VORTICELLA, an animalcule. See MICROSCOPE.

VOSGES, a department in the east of France, forming part of the ancient Lorraine. It takes its name from Mount Vosges, which forms its eastern boundary. It is traversed by the upper branches of the Moselle. The soil of this department is poor in the hilly parts, but tolerably fertile in the plains. It produces vines, though not to a great extent. There are mines of iron, copper, lead, and silver, and quarries of marble. The manufactures are trifling. The extent of the department is 587,955 hectares, and the population in 1817 was 334,169. Epinal is the chief town.

VOSSIUS, JOHN GERARD, a most learned and laborious writer of the 17th century, was of a considerable family in the Netherlands; and was born in 1577, in the palatinate, near Heidelberg, at a place where his father John Vossius was minister. He was made director of the college of Dort, and afterwards professor of eloquence and chronology at Leyden, from whence he was called in 1633 to Amsterdam, to fill the chair of professor of history. He died in 1649.

VOTE, the suffrage or resolve of each of the members of an assemblage, where any affair is to be carried by a majority; but more particularly used for the resolves of the members of either house of parliament.

VOTIVE MEDALS, those on which are expressed the vows of the people for the emperors. See MEDAL.

VOW, a solemn religious promise or oath. See OATH. The use of vows is found in most religions. They make up a considerable part of the Pagan worship, being made either in consequence of some deliverance, under some pressing necessity, or for the success of some enterprise. Among the Jews, all vows were to be voluntary, and made by persons wholly in their own power; and if such person made a vow in any thing lawful and possible, he was obliged to fulfil it. If he appointed no particular time for accomplishing his vow, he was bound to do it instantly, lest by delay he should prove less able, or be unwilling, to execute his promise. Among the Romanists, a person is constituted a religious by taking three vows; that of poverty, chastity, and obedience.

Vows, among the Romans, signified sacrifices, offerings, presents, and prayers made for the Cæsars, and emperors, particularly for their prosperity and the continuance of their empire. These were at first made every five years, then every 15, and afterwards every 20, and were called *quinquennalia*, *decennalia*, and *vicennalia*.

VOWEL, in *Grammar*, a letter which affords a complete sound of itself, or a letter so simple as only to need a bare opening of the mouth to make it heard, and to form a distinct voice. The vowels are six in number, viz. A, E, I, O, U, Y.

VOWEL, *John*. See HOOKER.

UPHOLSTER, UPHOLSTERER, or *Upholder*, a tradesmen that makes beds, and all sorts of furniture thereunto belonging, &c.

UPLAND, denotes high ground, or, as some call it, *terra firma*, by which it stands opposed to such as is moorish, marshy, or low.

UPLAND, a province of Sweden, bounded on the north-east by the Baltic sea, on the south by the sea of Sudermania, and on the west by Westmania and Gestricia, from which it is separated by the river Dela. It is about 70 miles in length and 45 in breadth, and contains mines of iron and lead. Stockholm is the capital.

UPSAL, a rich and considerable city of Sweden, in Upland, with a famous university, and an archbishop's see. The town is pretty large, and as straight as a line; but most of the houses are of wood, covered with birch bark, with turf on the top. On an eminence, to the south of the town, is a ruined castle. It was formerly the residence of the kings, and is now the usual place where they are crowned. It is seated on the river Sala. It is 26 miles north-west of Stockholm. E. Long. 17. 48. N. Lat. 59. 52.

UPUPA, a genus of birds belonging to the order of *Picæ*. See ORNITHOLOGY *Index*.

UR, in *Ancient Geography*, a citadel of Mesopotamia, situated between the Tigris and Nisibis; taken by some for Ur of the Chaldees, the residence of Abraham. What seems to confirm this is, that from Ur to Haran, the other residence of the patriarch, the road lies directly for Palestine. And it is no objection that Ur is said to be in Mesopotamia; because the parts next the Tigris were occupied by the Chaldeans, as seems to be confirmed from Acts vii. 2, 4. It is called *Orche*, in Strabo; *Orchoe*, in Ptolemy.

URALIAN CHAIN, a range of mountains which form part of the boundaries of Asia; anciently known by the name of *Riphæi Montes*. See RIPHÆI *Montes*, and GEOLOGY *Index*.

URANIA, in fabulous history, one of the nine Muses, was supposed to preside over astronomy. She is commonly represented in an azure robe, crowned with stars, and supporting a large globe with both hands.

URANIUM, one of the lately discovered metals. See CHEMISTRY and MINERALOGY *Index*.

URANOSCOPUS, a genus of fishes belonging to the order of *jugulares*. See ICHTHYOLOGY *Index*.

RAPHAEL D'URBINO. See RAPHAEL.

URCHIN, or HEDGEHOG. See ERINACEUS, MAMMALIA *Index*.

Sea URCHIN. See ECHINUS, HELMINTHOLOGY *Index*.

UREA. See CHEMISTRY.

URETERS. See ANATOMY, N° 101.

URETHRA. See ANATOMY, N° 107.

URIC Acid. See CHEMISTRY *Index*.

URIM and THUMMIM, among the ancient Hebrews, a certain oracular manner of consulting God, which was done by the high-priest dressed in his robes, and having on his pectoral or breast-plate.

Various have been the sentiments of commentators concerning the urim and thummim. Josephus, and several others, maintain, that it meant the precious stones set in the high-priest's breast-plate, which by extraordinary lustre made known the will of God to those who consulted him. Spencer believes that the urim and thummim were two little golden figures shut up in the pectoral as in a purse, which gave responses with an articulate voice. In short, there are as many opinions concerning the urim and thummim as there are particular authors that wrote about them. The safest opinion, according to Broughton, seems to be, that the words *urim* and *thummim* signify some divine virtue and power annexed to the breast-plate of the high-priest, by which an oraculous answer was obtained from God when he was consulted by the high-priest; and that this was called *urim* and *thummim*, to express the clearness and perfection which these oracular answers always carried with them; for urim signifies "light," and thummim "perfection:" these answers not being imperfect and ambiguous, like the heathen oracles, but clear and evident. The use made of the urim and thummim was to consult God in difficult cases relating to the whole state of Israel; and sometimes in cases relating to the king, the sanhedrim, the general of the army, or some other great personage.

URINAL, in *Medicine*, a vessel fit to receive and hold urine, and used accordingly for the convenience of sick persons. It is usually of glass, but sometimes of metal.

URINE, a fluid, separated from the blood, and carried by the emulgent arteries to the kidneys, from whence it descends to the bladder by the ureters, and is from time to time emitted thence by the canal of the urethra. See ANATOMY, N° 107. For the properties of urine, see CHEMISTRY *Index*.

URN, a kind of vase, of a roundish form, but biggest in the middle, like the common pitchers; now seldom used but in the way of ornament over chimney-pieces, in buffets, &c. The great use of urns among the ancients, was to preserve the ashes of the dead after they were burnt; for which reason they were called *cineraria*, and *urnæ cinerariæ*, and were placed sometimes under the tombstone whereon the epitaph was cut; and sometimes in vaults in their own houses. Urns were also used at their sacrifices to put liquid things in.

UROGALLUS. See TETRAO, ORNITHOLOGY *Index*.

URSA, in *Astronomy*, the name of two constellations in the northern hemisphere

URSULINES, in church history, an order of nuns, founded originally by St Angela of Brescia, in the year 1537; and so called from St Ursula, to whom they were dedicated.

URSUS, the BEAR, a genus of quadrupeds belonging to the order of *feræ*. See MAMMALIA *Index*.

URTICA, a genus of plants of the class of monœcia; and in the natural system classed under the 53d order, *Scabridæ*. See BOTANY *Index*.

URTICA Marina. See *ANIMAL-Flower*.

USANCE, in *Commerce*, is a determined time fixed for the payment of bills of exchange, reckoned either from the day of the bills being accepted, or from the day of their date; and thus called because regulated by the usage and custom of the places whereon they are drawn.

USE, in *Law*, the profit or benefit of lands and tenements; or a trust and confidence reposed on a person for the holding of lands, &c. that he to whose use the trust is made shall receive the profits.

USHANT, an island of France, 15 miles west of the coast of Britanny, at the entrance of the British channel.

USHER, an officer or servant who has the care and direction of the door of a court, hall, chamber, or the like.

USHER of the Black Rod, the eldest of the gentlemen ushers, daily waiters at court, whose duty is to bear the rod before the king at the feast of St George, and other solemnities.

USK, a river of Wales, which rises on the west of Brecknockshire, and runs south-east through that county and Monmouthshire, falling into the mouth of the Severn.

USQUEBAUGH, a strong compound liquor, chiefly taken by way of dram.

There are several different methods of making this liquor; but the following is esteemed one of the best: To two gallons of brandy, or other spirits, put a pound of Spanish liquorice, half a pound of raisins of the sun, four ounces of currants, and three of sliced dates; the tops of baum, mint, savory, thyme, and the tops of the flowers of rosemary, of each two ounces; cinnamon and mace well bruised, nutmegs, aniseeds, and coriander seeds, bruised likewise, of each four ounces; of citron or lemon, and orange-peel, scraped, of each an ounce: let all these infuse 48 hours in a warm place, often shaking them together; then let them stand in a cool place for a week: after which the clear liquor is to be decanted off, and to it is to be put an equal quantity of neat white port, and a gallon of canary; after which it is to be sweetened with a sufficient quantity of double refined sugar.

USTION, in *Pharmacy*, the preparing of certain substances by burning them.

USUFRUIT, in the *Civil Law*, the use or enjoyment of any lands or tenements; or the right of receiving the fruits and profits of an inheritance, or other thing, without a power of alienating or changing the property thereof.

USURER, a person charged with a habit or act of usury.

USURIOUS CONTRACT, is any bargain or contract whereby a man is obliged to pay more interest for money than the statute allows.

USURPATION, in *Law*, is an injurious using or enjoyment of a thing for continuance of time, that belongs of right to another.

USURY, an unlawful contract upon the loan of money, to receive the same again with exorbitant increase. Under the article INTEREST, it was observed, that by statute 37 Hen. VIII. c. 9. the rate of interest was fixed at 10l. per cent. per annum: which the statute 13 Eliz. c. 8. confirms, and ordains, that all brokers shall be guilty of a *præmunire* who transact any contracts for more, and the securities themselves shall be void. The statute 21 Jac. I. c 17. reduced interest to 8l. per cent.; and it having been lowered in 1650, during the usurpation, to 6 per cent. the same reduction was re-enacted after the Restoration by statute 12 Car. II. c. 13. and, lastly, the statute 12 Annæ, st. 2. c. 16. has reduced it to 5 per cent. Wherefore not only all contracts for taking more are in themselves totally void, but also the lender shall forfeit treble the money borrowed. Also if any scrivener or broker take more than 5s. per cent. procuration-money, or more than 12d. for making a bond, he shall forfeit 20l. with costs, and shall suffer imprisonment for half a-year.

UTERUS. See ANATOMY, N° 108.

UTICA, in *Ancient Geography*, a town of Africa Propria, on the Mediterranean: a Tyrian colony, and older than Carthage, (Sil. Italicus); its name, according to Bochart, denoting *old*: reckoned second to it; but after the destruction of Carthage, became the capital and centre of all the Roman transactions in Africa, according to Strabo; who adds, that it stood on the same bay with Carthage, at one of the promontories called *Apollonium*, bounding the bay on the west side, the other to the east called *Hermeia*, being at Carthage. It became famous by the death of Cato who thence was called *Uticensis*.

UTRECHT, one of the seven United Provinces or States of Holland, wholly surrounded by Holland and Guelderland, excepting a small part of it that borders on the Zuyder Zee. Its greatest length is about 32 miles, and breadth about 22. It enjoys a good air; and in most places the soil is fruitful, but in some sandy, or what is called *turf-ground*, and in others overrun with wood. It is watered by the Leck, Rhine, Vecht, and other smaller rivers, besides several canals; of which that extending from the village of Vreeswyk to Utrecht is one of the chief.

UTRECHT, in Latin *Ultrajectum*, *Trajectum vetus* or *inferius*, or *Trajectum Rheni*, capital of a province of the same name, so called from its ancient ferry or passage here over the Rhine; the word being compounded of *trecht*, which in Dutch signifies "a ferry," and *oud* or *olt*, i. e. "old." It is a fair, large, and populous city, situated 19 miles from Amsterdam, 25 from Rotterdam, and 27 from Leyden. Here is a stately town-house, with a commandery of the Teutonic order, and a celebrated university, which was founded in 1630, since which it hath flourished greatly, though it has not all the privileges of most other universities; being wholly subject to the magistrates of the city. The mall without the town, having five rows of lofty limes on each side, is very pleasant: and the physic-garden belonging to the university is extremely curious. There are five churches here that have chapters; but the members of these purchase the places, of which some cost 6000 or 7000 guilders. The streams which run through several of the streets, contribute much to the beauty and cleanliness of the town; and the canal that is cut from the Leck, and passes through it to Amsterdam, will carry ships of any burden. Pope Adrian VI. was a native of this city. Here, in 1579, the memorable union was formed between the seven provinces; and, in 1713, the celebrated peace concluded between France on the one part, and the allies on the other. The Papists have a nominal archbishop of this city; and there is a silk manufactory carried on in it, which employs a number of hands. The inhabitants are supposed to amount to 30,000. E. Long. 5. 8. N. Lat. 52. 7.

UTRICULARIA, a genus of plants of the class of diandria; and in the natural system arranged under the 24th order, *Corydales*. See BOTANY *Index*.

UVA URSI. See ARBUTUS, BOTANY *Index*.

VULCAN, in Pagan worship, the god of subterraneous fire and metals, was the son of Jupiter and Juno; and was said to be so remarkably deformed, that his father threw him down from heaven to the isle of Lemnos, in which fall he broke his leg, and there he set up his forge, and taught men how to soften and polish brass and iron. Thence he removed to the Liparian isles, near Sicily, where, by the assistance of the Cyclops, he made Jupiter's thunderbolts, and armour for the other gods. Notwithstanding the deformity of his person, he had a passion for Minerva, and by Jupiter's consent made his addresses to her, but without success. He was, however, more fortunate in his suit to Venus; who, after marriage, chose Mars for her gallant; when Vulcan exposed them to the ridicule of the other gods, by taking them in a net.

VULGATE, a very ancient Latin translation of the Bible, and the only one acknowledged by the church of Rome to be authentic. See BIBLE.

VULNERARY, in *Medicine*, an epithet formerly given to remedies supposed to possess virtues for the cure of wounds and ulcers.

VULTUR, a genus of birds belonging to the order of *Accipitres*. See ORNITHOLOGY *Index*.

VULVA. See ANATOMY, N° 132.

UVULA. See ANATOMY, N° 102.

UZ, or UTZ, the country and place of residence of Job. In the genealogy of the patriarchs there are three persons called *Uz*, either of which might give this district its name. The first was the grandson of Sem, by his son Aram (Gen. xxii. 23.), who, according to Josephus, occupied the Trachonitis, and Damascus, to the north of Palestine: but Job was among the sons of the East. Another *Uz* was the son of Nahor, Abraham's brother (Gen. x. 21.), who appears to have removed, after passing the Euphrates, from Haran of Mesopotamia to Arabia Deserta. The third *Uz* was a Horite, from Mount Seir (Gen. xxxvi. 28.), and thus not of Eber's posterity. Now the question is, from which of these Job's country, Uz, took its name: Not from the first, as is already shown; nor from the second, because his country is always called *Seir*, or *Edom*, never *Uz*; and then called a *south*, not an *east*, country, in Scripture. It therefore remains, that we look for the country and place of residence of Job in Arabia Deserta; for which there were very probable reasons. The plunderers of Job are called *Chaldeans* and *Sabeans*, next neighbours to him. These Sabeans came not from Arabia Felix, but from a nearer Sabe in Arabia Deserta (Ptolemy); and his friends, except Eliphaz the Themanite, were of Arabia Deserta.

UZBECK TARTARY. See TARTARY.

W.

W, or w, is the 21st letter of our alphabet; and is composed, as its name implies, of two v's. It was not in use among the Hebrews, Greeks, or Romans; but chiefly peculiar to the northern nations, the Teutones, Saxons, Britons, &c. But still it is not used by the French, Italians, Spaniards, or Portuguese, except in proper names, and other terms borrowed from languages in which it is originally used, and even then it is sounded like the single v. This letter is of an ambiguous nature; being a consonant at the beginning of words, and a vowel at the end. It may stand before all the vowels except *u*; as *water*, *wedge*, *winter*, *wonder*: it may also follow the vowels *a*, *e*, *o*, and unites with them into a kind of double vowel, or diphthong; as in *saw*, *few*, *cow*, &c. It also goes before *r*, and follows *s* and *th*; as in *wrath*, *swear*, *thwart*: it goes before *h* also, though in reality it is sounded after it; as in *when*, *what*, &c. In some words it is obscure, as in *shadow*, *widow*, &c.

WAAG, a river of Hungary, which rises in the Carpathian mountains, and falls into the Danube opposite to the island of Schut.

WAAL, a river of the United Netherlands, being one of the branches of the Rhine, which runs from east to west, through Guelderland; passing by Nimeguen, Tiel, Bommel, and Gorcum; and, uniting with the Maes, falls into the German sea below the Briel.

WACHENDORFIA, a genus of plants of the class of of triandria; and arranged in the natural method under the 6th order, *Ensatæ*. See BOTANY *Index*.

WADD, or WADDING, is a stopple of paper, hay, straw, or the like, forced into a gun upon the powder, to keep it close in the chamber; or to put up close to the shot, to keep it from rolling out.

WADSET, in *Scots Law*. See LAW, N° clxix. 1.

WAFERS, or *Sealing Wafers*, are made thus: Take very fine flour, mix it with glair of eggs, isinglass, and a little yeast; mingle the materials; beat them well together; spread the batter, being made thin with gum-water, on even tin plates, and dry them in a stove; then cut them out for use.

You may make them of what colour you please, by tinging the paste with brasil or vermilion for red; indigo or verditer, &c. for blue; saffron, turmeric, or gamboge, &c. for yellow.

WAGER *of Law*. See (*Wager of*) LAW.

Wager of Battel. See (*Wager of*) BATTEL.

WAGGON, a wheel-carriage, of which there are various forms, accommodated to the different uses they are intended for. The common waggon consists of the shafts or rods, being the two pieces which the hind horse bears up; the welds; the slotes, or cross pieces, which hold the shafts together; the bolster, being that part on which the fore-wheels and the axle-tree turn in wheeling the waggon across the road; the chest or body of the waggon, having the staves or rails fixed thereon; the bales, or hoops which compose the top; the tilt, the place covered with cloth, at the end of the waggon. See MECHANICS, Sect. iv.

WAGTAIL. See MOTACILLA, ORNITHOLOGY *Index*.

WAIFS, BONA WAVIATA, are goods stolen, and waived or thrown away by the thief in his flight, for fear of being apprehended. These are given to the king by the law, as a punishment upon the owner for not himself pursuing the felon, and taking away his goods from him. And therefore if the party robbed do his diligence immediately to follow and apprehend the thief (which is called *making fresh suit*), or do convict him afterwards, or procure evidence to convict him, he shall have his goods again. Waived goods do also not belong to the king till seized by somebody for his use; for if the party robbed can seize them first, though at the distance of 20 years, the king shall never have them. If the goods are hid by the thief, or left anywhere by him, so that he had them not about him when he fled, and therefore did not throw them away in his flight; these also are not *bona waviata*, but the owner may have them again when he pleases. The goods of a foreign merchant, though stolen and thrown away in flight, shall never be waifs: the reason whereof may be, not only for the encouragement of trade, but also because there is no wilful default in the foreign merchant's not pursuing the thief, he being generally a stranger to our laws, our usages, and our language.

WAIGATS STRAITS, situated between Nova Zembla and Russia, through which the Dutch sailed to the north, as high as 75°, in order to discover a north-east passage to China and the East Indies.

WAINSCOT, in building, the timber-work that serves to line the walls of a room, being usually made in pannels, and painted, to serve instead of hangings.

WAIVE, in *Law*, a woman that is put out of the protection of the law. She is called *waive*, as being forsaken of the law; and not an *outlaw* as a man is; by reason women cannot be of the decenna, and are not sworn in leets to the king, nor to the law, as men are; who are therefore within the law; whereas women are not, and so cannot be outlawed, since they never were within it.

WAKE, the print or track impressed by the course of a ship on the surface of the water. It is formed by the re-union of the body of water which was separated by the ship's bottom whilst moving through it; and may be seen to a considerable distance behind the stern, as smoother than the rest of the sea. Hence it is usually observed by the compass, to discover the angle of lee-way.

A ship is said to be in the wake of another when she follows her on the same track, or a line supposed to be formed on the continuation of her keel.

Two distant objects observed at sea are called in the wake of each other, when the view of the farthest is intercepted by the nearest so that the observer's eye and the two objects are all placed upon the same right line.

WAKE is the eve-feast of the dedication of churches, which is kept with feasting and rural diversions.

Mr Whitaker, in his History of Manchester, has given a particular account of the origin of wakes and fairs. He observes, that every church at its consecration received the name of some particular saint; this custom was practised among the Roman Britons, and continued among the Saxons; and in the council of Cealchythe, in 816, the name of the denominating saint was expressly required to be inscribed on the altars, and also on the walls of the church, or a tablet within it. The feast of this saint became of course the festival of the church. Thus Christian festivals were substituted in the room of the idolatrous anniversaries of heathenism: accordingly, at the first introduction of Christianity among the Jutes of Kent, Pope Gregory the Great advised, what had been previously done among the Britons, viz. Christian festivals to be instituted in the room of the idolatrous, and the suffering day of the martyr whose relics were reposited in the church, or the day on which the building was actually dedicated, to be the established feast of the parish. Both were appointed and observed; and they were clearly distinguished at first among the Saxons, as appears from the laws of the Confessor, where the *dies dedicationis*, or *dedicatio*, is repeatedly discriminated from the *propria festivitas sancti*, or *celebratio sancti*. They remained equally distinct to the Reformation; the dedication-day in 1536 being ordered for the future to be kept on the first Sunday in October, and the festival of the patron saint to be celebrated no longer. The latter was, by way of pre-eminence, denominated the *church's holiday*, or its peculiar festival; and while this remains in many parishes at present, the other is so utterly annihilated in all, that Bishop Kennet (says Mr Whitaker) knew nothing of its distinct existence, and has attributed to the day of dedication what is true only concerning the saint's day. Thus instituted at first, the day of the tutelar saint was observed, most probably by the Britons, and certainly by the Saxons, with great devotion. And the evening before every saint's day, in the Saxon Jewish method of reckoning the hours, being an actual hour of the day, Wake. and therefore like that appropriated to the duties of public religion, as they reckoned Sunday from the first to commence at the sunset of Saturday; the evening preceding the church's holiday would be observed with all the devotion of the festival. The people actually repaired to the church, and joined in the services of it; and they thus spent the evening of their greater festivities in the monasteries of the North, as early as the conclusion of the seventh century.

These services were naturally denominated from their late hours *wæcan* or *wakes*, and *vigils* or *eves*. That of the anniversary at Rippon, as early as the commencement of the eighth century, is expressly denominated the *vigil*. But that of the church's holiday was named *cyric wæcan*, or church-wake, the church-vigil, or church eve. And it was this commencement of both with a wake, which has now caused the days to be generally preceded with vigils, and the church-holiday particularly to be denominated the *church-wake*. So religiously was the eve and festival of the patron saint observed for many ages by the Saxons, even as late as the reign of Edgar, the former being spent in the church, and employed in prayer. And the wakes, and all the other holidays in the year, were put upon the same footing with the Octaves of Christmas, Easter, and of Pentecost. When Gregory recommended the festival of the patron saint, he advised the people to erect booths of branches about the church on the day of the festival, and to feast and be merry in them with innocence. Accordingly, in every parish, on the returning anniversary of the saint, little pavilions were constructed of boughs, and the people indulged in them to hospitality and mirth. The feasting of the saint's day, however, was soon abused; and even in the body of the church, when the people were assembled for devotion, they began to mind diversions, and to introduce drinking. The growing intemperance gradually stained the service of the vigil, till the festivity of it was converted, as it now is, into the rigour of a fast. At length they too justly scandalized the Puritans of the last century, and numbers of the wakes were disused entirely, especially in the east and some western parts of England; but they are commonly observed in the north, and in the midland counties.

This custom of celebrity in the neighbourhood of the church, on the days of particular saints, was introduced into England from the continent, and must have been familiar equally to the Britons and Saxons; being observed among the churches of Asia in the sixth century, and by those of the west of Europe in the seventh. And equally in Asia and Europe, on the continent and in the islands, those celebrities were the causes of those commercial marts which we denominate *fairs*. The people resorted in crowds to the festival, and a considerable provision would be wanted for their entertainment. The prospect of interest invited the little traders of the country to come and offer their wares; and thus, among the many pavilions for hospitality in the neighbourhood of the church, various booths were erected for the sale of different commodities. In larger towns, surrounded with populous districts, the resort of the people to the wakes would be great, and the attendance of traders numerous; and this resort and attendance constitute a fair.—Basil expressly mentions the numerous appearance of traders at these festivals in Asia, and Gregory notes the same custom to be common in Europe. And as the festival was observed on a feria or holyday, it naturally assumed to itself, and as naturally communicated to the mart, the appellation of *feria* or fair. Indeed several of our most ancient fairs appear to have been usually held, and have been continued to our time, on the original church-holydays of the places: besides, it is observable, that fairs were generally kept in church-yards, and even in the churches, and also on Sundays, till the indecency and scandal were so great as to need reformation.

Wake ‖ Wales.

Wake-Robin. See ARUM, BOTANY *Index*.

WALACHIA, a province of Turkey in Europe, bounded on the north by Moldavia and Transylvania; on the east and south by the river Danube, and on the west by Transylvania. It is 225 miles in length, and 125 in breadth; and was ceded to the Turks by the treaty of Belgrade, in 1739. It abounds in good horses and cattle; and there are mines of several kinds. The soil is so fertile, that it is capable of producing any thing; and there are good pastures, with wine, oil, and all manner of European fruits. The inhabitants are chiefly of the Greek church.

WALCHEREN, an island of the Low Countries, and one of the principal of those of Zealand; separated from Dutch Flanders by the mouth of the Scheldt. It is about nine miles in length, and eight in breadth; and though it lies low, has good arable and pasture land. The chief town of this island and the whole province is Middleburgh. But the principal sea port is Flushing, which is strongly fortified. Walcheren was taken by the British forces in August 1809; but it soon after was abandoned, the troops having suffered severely by sickness.

WALDEN, a town of Essex, commonly called *Saffron Walden*, with a market on Saturdays, and two fairs on Midlent Saturday for horses, and November 1st for cows. It is remarkable for the plenty of saffron that grows about it. This town was incorporated by Edward VI. and is governed by a mayor and 24 aldermen. It is 27 miles north-west-by-north of Chelmsford, and 43 north-east of London. E. Long. 0. 20. N. Lat. 52. 4.

WALDENSES. See WALDO.

WALDO, a merchant of Lyons in the latter part of the 12th century, who applying himself to the study of the Scriptures, and finding no warrant there for several of the Romish doctrines, particularly that of transubstantiation, publicly opposed them. His followers, who from him were called *Waldenses*, being chased from Lyons, spread over Dauphiné and Provence; upon which Philip II. is said to have razed 300 gentlemen's seats, and destroyed several walled towns to stop their growth: but this, instead of suppressing, spread them over a great part of Europe. The articles of their faith, which they drew up and dedicated to the king of France, agreed in most points with those of the present Protestants. In the year 1200, those of them who dwelt in the province of Albigeois in Languedoc, from whence they were called *Albigenses*, stood upon their defence; upon which Philip drove them into Bohemia, Savoy, and England. The crusade against them is said to have consisted of 500,000 men, who wore their crosses on their breasts, to distinguish themselves from those who went to the Holy Land, and wore them on their shoulders.

WALES, a country situated in the south-west part of of Britain, into which the ancient Britons retired from the persecution of the Saxons. Anciently it was of greater extent than it is at present, and comprehended all the country beyond the Severn; that is, besides the 12 counties included in it at present, those of Herefordshire and Monmouthshire, which now are reckoned a part of England, were then inhabited by three different tribes of the Britons, namely the Silures, the Dimetæ, and the Ordovices. The Romans were never able to subdue them, till the reign of Vespasian, when they were reduced by Julius Frontinus, who placed garrisons in their country to keep them in awe. Though the Saxons made themselves masters of all England, they never could get possession of Wales, except the counties of Monmouthshire and Herefordshire, formerly a part of Wales. About the year 870, Roderic king of Wales divided it among his three sons; and the names of these divisions were, *Demetia*, or *South-Wales; Povesia*, or *Powis-Land;* and *Venedotia*, or *North Wales.* Another division is mentioned afterwards in the records, viz. North Wales, South Wales, and West Wales; the last comprehending the counties of Monmouth and Hereford. The country derived the name of *Wales*, and the inhabitants that of *Welsh*, from the Saxons, who by those terms denote a country and people to which they are strangers; for the Welsh, in their own language, call their country *Cymry*, and their language *Cymraeg*. They continued under their own princes and laws from the above-mentioned period, and were never entirely subjected to the crown of England till the reign of Edward I. when Llewellin ap Gryffith, prince of Wales, lost both his life and dominions. Edward, the better to secure his conquest, and to reconcile the Welsh to a foreign yoke, sent his queen to lie in at Caernarvon, where she was delivered of a prince; to whom the Welsh, on that account, the more readily submitted. Ever since that time, the eldest sons of the kings of England have commonly been created princes of Wales, and as such enjoy certain revenues from that country.

As to the character of the Welsh, they are said to be a brave hospitable people; and though very jealous of affronts, passionate, and hasty, yet are easily reconciled. The common people look with a suspicious eye on strangers, and bear a hereditary grudge to the English nation, by whom their ancestors were expelled from the finest parts of the island. The gentlemen are apt to value themselves upon the antiquity of their families; and with some reason, as they can generally trace them much higher than the inhabitants of most other countries.

All the better sort, both in town and country, can speak English, especially in the counties bordering upon England. The common people, in general, only speak their own language, which is the ancient British; and not only differs entirely from the English, but has very little affinity with any of the western tongues, unless we should except the Gaelic, Erse, or Irish. It is said to be a dialect of the ancient Celtic, and in many respects to resemble the Hebrew. Most of the clergy are natives of the country, and understand English so well, that they could exercise their functions in any part of Britain. The public worship, however, is as often performed in Welsh as in English, excepting in the towns, where the latter is the prevailing language. According to the returns in 1811, the population of Wales was 611,788.

The country, though mountainous, especially in North Wales, is far from being barren or unfruitful; the hills, besides the metals and minerals they contain, feeding vast herds of small black cattle, deer, sheep, and goats, and their valleys abounding in corn, as their seas and rivers do in fish. Here are also wood, coal, and turf, for fuel, in abundance.

Wales is bounded on all sides by the sea and the Severn; except on the east, where it joins to the counties of Chester, Salop, Hereford, and Monmouth. Its length, from the southernmost part of Glamorganshire to the extremity of Flintshire north, is computed at about 113 miles; and its greatest breadth, from the river Wye east to St David's in Pembrokeshire west, is nearly of the same dimensions, being about 90 miles.

After the conquest of Wales by Edward I. very material alterations were made in their laws, so as to reduce them nearer to the English standard, especially in the forms of their judicial proceedings: but they still retained very much of their original polity, particularly their rule of inheritance, viz. that their lands were divided equally among all the issue male, and did not descend to the eldest son alone. By other subsequent statutes their provincial immunities were still farther abridged: but the finishing stroke to their dependency was given by the statute 27 Hen. VIII. c. 26. which at the same time gave the utmost advancement to their civil prosperity, by admitting them to a thorough communication of laws with the subjects of England.—Thus were this brave people gradually conquered into the enjoyment of true liberty; being insensibly put upon the same footing, and made fellow-citizens, with their conquerors.

It is enacted by the 27 Hen. VIII. 1. That the dominions of Wales shall be forever united to the kingdom of England. 2. That all Welshmen born shall have the same liberties as other king's subjects. 3. That lands in Wales shall be inheritable according to the English tenures and rules of descent. 4. That the laws of England, and no other, shall be used in Wales; besides many other regulations of the police of this principality. And the 34 and 35 Hen. VIII. c. 26. confirms the same, adds farther regulations, divides it into 12 shires, and in short, reduces it to the same order in which it stands at this day; differing from the kingdom of England in only a few particulars, and those too of the nature of privileges (such as having courts within itself, independent of the process of Westminster-hall), and some other immaterial peculiarities, hardly more than are to be found in many counties of England itself.

New WALES. See *New BRITAIN.*

New South WALES. See *New HOLLAND.*

Prince of WALES. See *ROYAL Family.*

WALKING Leaf, an insect. See *MANTIS Sycifolia*, ENTOMOLGY *Index.*

WALL, in *Architecture*, the principal part of a building, as serving both to inclose it, and to support the roof, floors, &c.—Walls are distinguished into various kinds, from the matter whereof they consist; as plaster or mud walls, brick walls, stone walls, flint or boulder walls, and boarded walls. See ARCHITECTURE.

Cob or *Mud WALL.* In those parts of England where stone is scarce, it is usual to make walls and houses of mud,

mud, or, as it is called in Devonshire, *cob*; which is a composition of earth and straw, wet up somewhat like mortar, but well beat and trod together. When a wall is making, after being raised to a certain height, it is allowed time to pitch or settle before the work is resumed. Some value themselves on their skill in building with this composition; the price, when materials are found, is generally in Devonshire 3s. per perch of 16½ feet; but a stone foundation costs more. Houses built with this, being covered with thatch, are very dry and warm; a cob wall, if in a good situation, will last 50 or 60 years or more. When pulled down, they are used as manure, and new earth employed to rebuild with.

WALLACE, Sir William, a gallant general of the Scots, who endeavoured to rescue his country from the English yoke; but being taken prisoner, he was unjustly tried by the English laws, condemned, and executed as a traitor to Edward I. in 1304. See Scotland, N° 103, *et seq.*

WALLACHIA. See Walachia.

WALLER, Edmund, a celebrated English poet, was the son of Robert Waller, Esq. of Agmondesham in Buckinghamshire, by Anne, the sister of the great Hampden who distinguished himself so much in the beginning of the civil wars. He was born in 1605; and his father dying when he was very young, the care of his education fell to his mother, who sent him to Eton school. He was afterwards sent to King's college in Cambridge, where he must have been very assiduous in his studies, since, at sixteen or seventeen years of age, he was chosen into the last parliament of King James I. and served as burgess for Agmondesham. He began to exercise his political talent so early as the year 1623; as appears from his verses "upon the danger his majesty (being prince) escaped in the road of St Andero;" for there Prince Charles returning from Spain that year, had like to have been cast away. It was not, however, Mr Waller's wit, his fine parts, or his poetry, that so much occasioned him to be first publicly known, as his carrying off the daughter and sole heiress of a rich citizen, against a rival whose interest was espoused by the court. It is not known at what time he married his first lady; but he was a widower before he was 25, when he began to have a passion for Sacharissa, which was a fictitious name for the lady Dorothy Sidney, daughter to the earl of Leicester, and afterwards wife to the earl of Sunderland. He was now known at court, caressed by all who had any relish for wit and polite literature; and was one of the famous club of which Lord Falkland, Mr Chillingworth, and other eminent men, were members. He was returned burgess for Agmondesham in the parliament which met in April 1640. An intermission of parliaments having disgusted the nation, and raised jealousies against the designs of the court, which would be sure to discover themselves whenever the king came to ask for a supply, Mr Waller was one of the first who condemned the preceding measures. He showed himself in opposition to the court, and made a speech in the house on this occasion; from which we may gather some notion of his general principles in government; wherein, however, he afterwards proved very variable and inconstant. He opposed the court also in the long parliament which met in November following, and was chosen to impeach Judge Crawley, which he did in a warm and eloquent speech, July 16th 1641. This speech was so highly applauded, that 20,000 copies of it were sold in one day. In 1642, he was one of the commissioners appointed by the parliament to present their propositions of peace to the king at Oxford. In 1643, he was deeply engaged in a design to reduce the city of London and the Tower to the service of the king; for which he was tried and condemned, together with Mr Tomkins his brother-in-law, and Mr Challoner. The two latter suffered death; but Mr Waller obtained a reprieve: he was, however, sentenced to suffer a year's imprisonment, and to pay a fine of 10,000l. After this, he became particularly attached to Oliver Cromwell, upon whom he wrote a very handsome panegyric. He also wrote a noble poem on the death of that great man.

At the Restoration, he was treated with great civility by Charles II. who always made him one of the party in his diversions at the duke of Buckingham's and other places. He wrote a panegyric upon his majesty's return; which being thought to fall much short of that he had before written on Oliver Cromwell, the king one day asked him in raillery, "How is it, Waller, that you wrote a better encomium on Cromwell than on me?" "May it please your majesty," answered he, "we poets generally succeed best in fiction." He sat in several parliaments after the Restoration, and continued in the full vigour of his genius to the end of his life, his natural vivacity bearing him up, and making his company agreeable to the last. He died of a dropsy in 1687, and was interred in the churchyard of Beaconsfield, where a monument is erected to his memory. Mr Waller has been honoured as the most elegant and harmonious versifier of his time, and a great refiner of the English language. The best edition of his works, containing poems, speeches, letters, &c. is that published in quarto by Mr Fenton, to 1730.

WALLIS, Dr John, a celebrated mathematician, was educated at Cambridge; where he became fellow of Queen's college, and continued so till, by his marriage, he vacated his fellowship. In 1640, he received holy orders, and became chaplain to the lady Vere. While he lived in this family, he cultivated the art of deciphering; and it is said that the elector of Brandenburgh, for whom he explained several letters written in ciphers, sent him a gold chain and medal. In 1643 he published, "Truth tried; or Animadversions on the Lord Brooke's treatise, called *The Nature of Truth*, &c." The next year he was chosen one of the scribes or secretaries to the assembly of divines at Westminster. Dr Peter Turner, Savilian professor of geometry in Oxford, being ejected by the parliament-visitors in 1649, Mr Wallis was appointed to succeed him in that place. In 1653 he published at Oxford a Grammar of the English Tongue in Latin. In 1655 he entered the lists with Mr Hobbes; and their controversy lasted a considerable time. In 1657 the Doctor published his Mathematical Works. Upon the death of Dr Langbaine, he was chosen custos archivorum of the university. After the Restoration he met with great respect, the king himself entertaining a favourable opinion of him on account of some services he had done both to his royal father and himself. He was therefore confirmed in his places, admitted one of the king's chaplains in ordinary, and appointed one of the divines empowered to review the book of common prayer. He complied with the terms

Wallis || Walpole.

terms of the act of uniformity, and continued a steady conformist till his death. He was one of the first members of the Royal Society, and corresponded with many learned men. In 1697, the curators of the university press at Oxford thought it for the honour of the university to collect the mathematical works of the Doctor, which had been printed separately, some in Latin, some in English, and published them all together in the Latin tongue, in three vols, folio. He died in 1703. He speaks of himself thus: "It hath been my endeavour all along to act by moderate principles, being willing, whatever side was uppermost, to promote any good design for the true interest of religion, of learning, and of the public good." Besides the works above mentioned, he published many others.

WALLOONS, a name for the inhabitants of a considerable part of the Netherlands, viz Artois, Hainault, Naum, Luxemburgh, and part of Flanders and Brabant.

WALNUT-TREE. See JUGLANS, BOTANY *Index*.

WALPOLE, SIR ROBERT, earl of Orford, was born at Houghton in Norfolk, September 6th, 1674, and educated on the foundation at Eton school. Thence he was elected to King's College in Cambridge; but, succeeding to the family estate by the death of his elder brother, he resigned his fellowship. In 1700, he was chosen member of parliament for King's Lynn, and represented that borough in several succeeding parliaments. In 1705, he was nominated one of the council, to Prince George of Denmark, lord high admiral of England; in 1707, appointed secretary at war; and, in 1709, treasurer of the navy. In 1710, upon the change of the ministry, he was removed from all his posts, and held no place afterwards during the queen's reign. In 1711 he was expelled from the house of commons for what they called notorious corruption in his office as secretary at war. The borough of Lynn, however, re-elected him; and, though the house declared the election void, yet they persisted in the choice. In the well-known debate relating to Steele for publishing the Crisis, he greatly distinguished himself in behalf of liberty, and added to the popularity he had before acquired.

On the death of the queen, a revolution of politics took place, and the Whig party prevailed both at court and in the senate. Walpole had before recommended himself to the house of Hanover by his zeal for its cause, when the commons considered the state of the nation with regard to the Protestant succession: and he had now the honour to procure the assurance of the house to the new king (which attended the address of condolence and congratulation), "That the commons would make good all parliamentary funds." It is therefore not to be wondered at, that his promotion soon took place after the king's arrival; and that in a few days he was appointed receiver and paymaster-general of all the guards and garrisons, and of all other the land forces in Great Britain, paymaster of the royal hospital at Chelsea, and likewise a privy counsellor. On the opening of a new parliament, a committee of secrecy was chosen to inquire into the conduct of the late ministry, of which Walpole was appointed chairman; and, by his management, articles of impeachment were read against the earl of Oxford, Lord Bolingbroke, the duke of Ormond, and the earl of Strafford. The eminent service he was thought to have done the crown, by the vigorous prosecution of those ministers who were deemed the chief instruments of the peace, was soon rewarded by the extraordinary promotions to the offices of first commissioner of the treasury, and chancellor and under treasurer of the exchequer.

Walpole.

In two years time he resigned all his offices, on account of a misunderstanding which took place between him and the rest of the ministry about certain supplies demanded for the support of his majesty's German dominions. On the day of his resignation he brought in the famous sinking-fund bill, which he presented as a country gentleman, saying, that he hoped it would not fare the worse for having two fathers; and that his successor Mr Stanhope would bring it to perfection. His calling himself the father of a project, which hath since been so often employed to other purposes than were at first declared, gave his enemies frequent opportunity for satire and ridicule; and it hath been sarcastically observed, that the father of this fund appeared in a very bad light when viewed in the capacity of a nurse. In the next session of parliament, Walpole opposed the ministry in every thing; and even Wyndham or Shippen did not exceed him in patriotism. Upon a motion in the house for continuing the army, he made a speech of above an hour long, and displayed the danger of a standing army in a free country, with all the powers of eloquence. Early in 1720 the rigour of the patriot began to soften, and the complaisance of the courtier to appear; and he was again appointed paymaster of the forces, and several of his friends were found soon after in the list of promotions. No doubt now remained of his entire conversion to court measures; for before the end of the year, we find him pleading as strongly for the forces required by the war-office as he had before declaimed against them, even though at this time the same pretences for keeping them on foot did not exist.

It was not long before he acquired full ministerial power, being appointed first lord commissioner of the treasury, and chancellor of the exchequer; and, when the king went abroad in 1723, he was nominated one of the lords justices for the administration of government, and was sworn sole secretary of state. About this time he received another distinguished mark of the royal favour; his eldest son then on his travels being created a peer, by the title of Baron Walpole of Walpole. In 1725 he was made knight of the Bath, and the year after knight of the Garter. The measures of his administration, during the long time he remained prime or rather sole minister, have been often canvassed with all the severity of critical inquiry. It is difficult to discern the truth through the exaggerations and misrepresentations of party. He has indeed been accused of employing the sinking fund for the purposes of corruption, of which it was long the fashion to call him the father; but the man who reflects on the transactions of Charles II. and his infamous cabal, will acquit him of the latter part of this charge. He was an enemy to war, and the friend of commerce; and because he did not resent some petty insults of the court of Spain so suddenly as the fiery part of the nation thought he should have done, a formidable opposition was formed against him in the house, which had influence enough to

Walpole. to employ in its cause almost all the wit of the nation. Pulteney and Pitt were the great leaders of the party in the house of commons; while Bolingbroke and Pope and Johnson, and almost every man of genius, exerted themselves without doors to enlighten, by pamphlets in prose and verse, the minds of the people, and show the necessity of a Spanish war. This he strenuously opposed, because he knew that the foreign settlements of that power are very remote, and in a climate destructive to Englishmen; and that such of them as we might be able to take, we could not possibly retain. The opposition however prevailed. The nation was indulged in a war, of which it surely had no cause to boast of the success; and it is now universally known, that the greater part of those who with honest intentions had, either in parliament or out of it, been engaged to run down the minister, lived to repent of their conduct, and do justice to the man whom they had so pertinaciously vilified.

In order to encourage commerce and improve the revenue, Sir Robert projected a scheme for an extension of the excise, as the only means of putting a stop to the frauds of merchants and illicit traders. This was another ground of clamour to the orators within, and the wits without, doors; and while the opposition represented it as a measure big with public mischief, Swift and Pope occasionally alluded to it as an oppression calculated to deprive private life of all its comforts. The minister was therefore obliged to abandon the scheme; but in a succeeding administration it was partly carried into execution, at the express solicitation of the principal persons concerned in that article of trade which it was suggested would be most affected by it; and afterwards the most popular minister that ever directed the councils of this country declared in full senate, that if a time should ever arrive which was likely to render the project feasible, he would himself recommend an extension of the excise laws as a measure of the greatest advantage to commerce, to the revenue, and to the general interests of the kingdom.

In 1742 the opposition prevailed; and Sir Robert being no longer able to carry a majority in the house of commons, resigned all his places, and fled for shelter behind the throne. He was soon afterwards created earl of Orford; and the king, in consideration of his long and faithful services, granted him a pension of 4000l. per annum. The remainder of his life he spent in tranquillity and retirement, and died, in 1745, in the 71st year of his age.

He has been severely, and not unjustly, censured for that system of corruption by which he almost avowed that he governed the nation; but the objects which he had in view are now acknowledged to have been in a high degree praise-worthy. Johnson, who in the earlier part of his life had joined the other wits in writing against his measures, afterwards honoured his memory for the placability of his temper, and for keeping this country in peace for so many years; and Mr Burke has * declared, that his only defect as a minister was the want of sufficient firmness to treat with contempt that popular clamour, which, by his yielding to it, hurried the nation into an expensive and unjust war. But his rancorous prosecution of Atterbury bishop of Rochester (see ATTERBURY), by a bill of pains and penalties, may be considered as something worse than a defect: it was a fault for which no apology can be made; because, whether that prelate was innocent or guilty, of his guilt no legal proof ever appeared. In that instance the conduct of the minister was the more extraordinary, that on other occasions he chose to gain over the disaffected by mildness and beneficence, even when he had sufficient proofs of their guilt. Of this the following anecdote, communicated by Lord North to Dr Johnson, is a sufficient proof. Sir Robert having got into his hands some treasonable papers of his inveterate enemy Shippen, sent for him, and burnt them before his eyes. Some time afterwards, while Shippen was taking the oaths to the government in the house of commons, Sir Robert, who stood next to him, and knew his principles to be the same as ever, smiled; upon which Shippen, who had observed him, said "Egad, Robin, that's hardly fair."

* *Letters on a Regicide Peace.*

Walpole ‖ Walsingham.

To whatever objections his ministerial conduct may be liable, in his private character he is universally allowed to have had amiable and benevolent qualities. That he was a tender parent, a kind master, a beneficent patron, a firm friend, an agreeable companion, are points that have been seldom disputed; and so calm and equal was his temper, that Pulteney, his great rival and opponent, said, he was sure that Sir Robert Walpole never felt the bitterest invective against him for half an hour.

About the end of Queen Anne's reign, and the beginning of George I.'s he wrote the following pamphlets. 1. The Sovereign's Answer to the Gloucestershire Address. The Sovereign meant Charles duke of Somerset, so nicknamed by the Whigs. 2. Answer to the Representation of the House of Lords on the State of the Navy, 1709. 3. The Debts of the Nation stated and considered, in four Papers, 1710. 4. The Thirty-five Millions accounted for, 1710. 5. A Letter from a foreign Minister in England to Monsieur Pettecum, 1710. 6. Four Letters to a Friend in Scotland upon Sacheverell's Trial; falsely attributed in the General Dictionary to Mr Maynwaring. 7. A Short History of the Parliament. It is an account of the last session of the queen. 8. The South-Sea Scheme considered. 9. A Pamphlet against the Peerage Billl, 1719. 10. The Report of the Secret Committee, June 9th, 1715.

WALRUS. See TRICHECUS, MAMMALIA *Index*.

WALSH, WILLIAM, an English critic and poet, the son of Joseph Walsh, Esq. of Abberley in Worcestershire, was born about the year 1660. He became a gentleman commoner of Wadham college, Oxford, but left the university without taking a degree. His writings are printed among the works of the Minor Poets, printed in 1749. He was made gentleman of the horse in Queen Anne's reign; and died in 1708. He was the friend of Mr Dryden and of Mr Pope; the former of whom esteemed him the best critic then living; and Mr Pope has celebrated his character in the Essay on Criticism.

WALSINGHAM, a town of Norfolk, with a market on Fridays, and a fair on Whit-Monday, for horses and pedlars ware; it is seated not far from the sea; and in former times was famous for its college of canons, and was greatly frequented by pilgrims who went to pay their devotions to the image of the Virgin Mary at the chapel, where there are two fine springs, called the

the *Virgin Mary's wells*. Not many years ago there were found here by a husbandman, 100 urns full of ashes, which were supposed to be those which the Romans filled with the ashes of the dead. It is 22 miles north-west of Norwich, and 117 north-north-east of London. E. Long. 0. 53. N. Lat. 52. 56.

WALSINGHAM, *Thomas*, an English Benedictine monk of the monastery of St Alban's, who lived about the year 1440. He applied himself to the history and antiquity of his country, in quality of historiographer to the king; and composed the History of King Henry VI. with other works.

WALSINGHAM, *Sir Francis*, minister and secretary of state during the reign of Queen Elizabeth, and one of the greatest politicians of his time, was descended from a noble and ancient family at Chislehurst. After having made great progress in his studies at Cambridge, he was twice sent ambassador to France, and at his return to England was employed in the most important affairs, became secretary of state, and was one of the commissioners for the trial of Mary queen of Scotland. Sir Francis was undoubtedly one of the most refined politicians and most penetrating statesman that any age ever produced. He had an admirable talent, both in discovering and managing the secret recesses of the heart. He had his spies in most courts in Christendom, and allowed them a liberal maintenance; for it was his maxim, That knowledge cannot be bought too dear. In 1587 the king of Spain having made vast preparations, which surprised, and kept all Europe in suspense, Walsingham employed his utmost endeavours for the discovery of that important secret; and accordingly procured intelligence from Madrid, that the king had informed his council of his having dispatched an express to Rome, with a letter written with his own hand to the pope, acquainting him with the true design of his preparations, and begging his blessings upon him; which for some reasons he could not disclose till the return of the courier. The secret being thus lodged with the pope, Walsingham, by means of a Venetian priest, whom he retained at Rome as a spy, got a copy of the original letter, which was stolen out of the pope's cabinet by a gentleman of the bed chamber, who took the key out of the pope's pocket while he slept. After this, by his dexterous management, he caused the Spaniards bills to be protested at Genoa, which should have supplied them with money for their extraordinary preparations; and by this means he happily retarded this formidable invasion for a whole year. In short, he spent his whole time and faculties in the service of Queen Elizabeth; on which account her majesty was heard to say, "That in diligence and sagacity he exceeded her expectations." However, after all his eminent services to his country, this man gave a remarkable proof at his death, which happened on the 6th of April 1590, how far he preferred the public interest to his own; he being so poor, that excepting his library, which was a very fine one, he had scarcely effects enough to defray the expence of his funeral. His principal works are, 1. Memoirs and Instructions for the use of Ambassadors, with his Letters and Negociations. 2. Political Memoirs.

WALTHERIA, a genus of plants in the class monadelphia, and in the natural system arranged under the 37th order, *Columniferæ*. See BOTANY *Index*.

WALTON, BRYAN, bishop of Chester, a learned English divine, who gained great reputation by his edition of the Polyglot bible, with his Prolegomena in the beginning; which is more exact, says Father Simon, than any other which had been published on that subject. He died in 1661.

WAMPUM, the money used by the North American Indians. It is much used in all their treaties as a symbol of friendship. It is made of a shell of a particular species of VENUS.

WAPENTAKE, is the same with what is called a *hundred*; especially used in the north counties beyond the river Trent. The word seems to be of Danish original, and to be so called for this reason: When first this kingdom, or part thereof, was divided into wapentakes, he who was the chief of the wapentake or hundred, and who is now called a *high constable*, as soon as he entered upon his office, appeared in a field on a certain day on horseback with a pike in his hand, and all the chief men of the hundred met him there with their lances, and touched his pike; which was a sign that they were firmly united to each other by the touching their weapons. But Sir Thomas Smith says, that anciently musters were made of the armour and weapons of the several inhabitants of every wapentake; and from those that could not find sufficient pledges for their good abearing, their weapons were taken away and given to others; from whence he derives the word.

W A R.

INTRODUCTION.

1 Division of the subject.

IN treating the subject of war, we may consider it first in a *political* and *moral* point of view, as one of those powerful engines employed by civil governments, to bring about some ends which they deem beneficial to the community over which they preside; and secondly, in a *theoretical* and *practical* point of view, as a *science* or an *art*, which the necessities or the follies of mankind have rendered an important object of consideration, not only to certain individuals, but in some measure to society at large.

2 Political objects and causes of war.

From the numerous calamities incident to war, it should be presumed that no wise or good government would have recourse to means so dangerous and expensive, till after all other means of producing the ends they have in view had failed of success. The ostensible objects for which a nation or community engages in a war, are usually to prevent or repel the assaults, encroachments, or invasions of its neighbours; to revenge some insult or injury which the community, its allies, or dependents, may have sustained; to compel some other nation or community to respect what are called the *law of nations*, and the *rights of civil society*; or to preserve

Introduction.

preserve that due and equable *balance of power* among neighbouring states, which has of late been considered as an essential point in the political economy of civilized nations. We say that these are usually the *ostensible* objects of war; for though it will scarcely be denied that ambition, avarice, religious bigotry, a desire of dominion, and a thirst of military fame, have been the real causes of many of those long and bloody wars which have desolated the face of nature, and heaped misery and wretchedness on millions of human beings, we believe few heroes and conquerors, either of ancient or modern times, have had the honesty or effrontery to avow these as the real motives of their military expeditions. Yet, if we examine the pages of history, we shall scarcely find a war, from the Battle of the Kings recorded by the sacred historian, to the present contest which has for 17 years involved all Europe in confusion and bloodshed, and reduced many of its fairest states and provinces under the subjection of a single monarch, in which *one* or other of these latter motives has not, at least to one party, been a principal inducement.

Among the political objects of war, we must not omit to mention one which, though perhaps less openly avowed than any other, has, in monarchical and aristocratical governments, always formed a material part of the state policy;—we mean the object of preventing tumults and commotions among the people, by engaging them in a foreign war. It was long ago observed by a good judge of human nature *, "that no body can be healthful without exercise, neither natural body nor politic;" and that "to a kingdom or a state, a just and honourable war is the true exercise." That politicians have often acted on these principles, is certain. On the justice of the principles themselves, we presume not to decide, though we may safely express a doubt whether the remedy be not worse than the disease, and whether these popular commotions might not be prevented with equal ease, and with more advantage to the nation, by employing the populace in such works of improvement as may advance the manufactures, commerce, or internal comforts of the state.

* *Bacon.*

3
Exuberant population regarded as a primary cause of war.

An able and ingenious writer considers a redundance of population as one of the chief primary causes of war. "One of its first causes and most powerful impulses, was undoubtedly an insufficiency of room and food; and, greatly as the circumstances of mankind have changed since it first began, the same cause still continues to operate, and to produce, though in a smaller degree, the same effects. The ambition of princes would want instruments of destruction, if the distresses of the lower classes did not drive them under their standards. A recruiting serjeant always prays for a bad harvest, and a want of employment, or, in other words, a redundant population †." This redundance he proposes to obviate, and thus to counteract one of the principal causes of war, by throwing obstacles in the way of marriage. Without calling in question the justness of his position, we do not see the necessity of the remedy which he proposes. We must acknowledge ourselves such friends to the increase of population as to think that every encouragement ought to be given to it, instead of throwing obstacles in its way. There are few countries so populous, or so completely cultivated, as to render it necessary to plunge them into wars, in order to diminish the number of inhabitants, which might be abundantly supported, were agriculture encouraged, and gluttony repressed.

† *Malthus on Population*, Edit. 1803. p. 500.

4
Impolicy of war.

Whatever may be the objects for which a nation goes to war; whatever the causes which have induced her to have recourse to such an expedient, we may venture, from history and experience, to affirm that she will gain little solid advantage by the contest. She may drive an invading enemy from her dominions, and pursue him to his own; she may acquire plunder and territory, and may raise her name among the neighbouring states by her victories and prowess; but all these, except the *first*, will scarcely compensate for the blood and treasure which she has expended, and for the check given to her agriculture, manufactures and commerce, by drawing off many of the labouring part of the community to supply the fleets and armies of the state. These are the inevitable consequences even of a successful war; and should it prove otherwise, the calamities and distresses of the vanquished may readily be conceived. Even to the established government of a state, war, while it appears to strengthen their hands and increase their influence, is fraught with difficulty and danger. No situation of affairs is so well calculated to show the abilities or insufficiency of a cabinet as this, and melancholy is the fate of that nation whose administration is then conducted by a weak, inexperienced, or profligate ministry; but be they ever so able or so upright, still the want of success, or a reverse of fortune, will lower them in the opinion of the people, and will compel them at last to conclude a disadvantageous, perhaps a dishonourable peace, or quit their posts and leave the task to a more popular or successful administration.

The evils of war do not terminate on the return of peace. Many of the burdens which it had imposed on the people must still continue, to discharge the debt contracted by the state; while the sudden disbanding of the fleets and armies pours into the community numbers of idle and dissipated men, averse to labour, and accustomed to scenes of confusion, slaughter and rapine. At no time are robberies, murders, or seditions, so frequent as on the termination of a long protracted war; at none are the internal peace and quiet of a nation in so much danger.

5
Moral evils of war.

On the *moral* evils of war we surely need not enlarge. In itself, when undertaken without necessity, it is an act of the most criminal and atrocious nature; and the aggressors are accountable for all the horrid consequences which may attend it. "The pomp and circumstances of glorious war" may form a desirable subject for the poet and the historian; but the Christian and the philosopher must regard it with horror and detestation, as the greatest evil with which providence has been pleased to arm the hands of its ministers to punish and afflict mankind. A late amiable and learned prelate has laboured to prove that "the frequency, duration, and cruelty of wars (in Christendom) are less now than in ancient times;"* but we think that neither his reasoning nor his examples are capable of establishing the first part of this position. If we take the last 700 years, and compare it with an equal period of ancient history; if we recollect the *crusades*, the almost continual struggles between France and Britain, the civil dissensions in both these mighty empires, the wars between the Russians and their neighbours, the Turks, the Poles, and the Swedes; if we advert to the reigns of Edward

6
War scarcely less frequent now than formerly.

* *Porteus's Sermons*, Serm. xi.

Introduction. Edward III. of England, Charles V. and Philip II. of Spain, Louis XIV. of France, Gustavus Adolphus and Charles XII. of Sweden, Frederick II. of Prussia, and Catherine II. of Russia; and lastly, if we turn our attention to the long and ruinous contests which distinguish our own times, we shall find little cause to boast of having profited by the specific lessons of our Saviour, whose great object was to promote "*peace on earth,*" *and good will and brotherly love among the children of men.*

7 Modern wars less sanguinary than those of ancient times.

There is indeed one consolatory circumstance with respect to the modern system of warfare, that our wars are now less sanguinary than those of ancient times. The immense slaughter which attended some of the battles in the Greek and Roman wars, where the greater part of the vanquished army was frequently put to the sword, is familiar to our classical readers; but in modern warfare, even of the large armies that have appeared in the field on the continent of Europe, we seldom find so many as 30,000 killed and wounded on both sides, a number vastly inferior to what fell of the Romans at Cannæ, and by no means equal to the loss of the Carthaginians at the battle of Zama. This diminished slaughter is attributed, and we believe with justice, to the use of fire-arms; and it is computed that in this mode of fighting not more than one musket ball in 40 takes effect, and not more than one in 400 proves fatal. The introduction of these weapons, therefore, however it may be declaimed against by theorists, must be considered as a real improvement in the art of war; and it is sincerely to be regretted that the use of them should be laid aside. If, however, the present practice of deciding battles by the bayonet and the sabre be continued, it is to be feared that we shall soon rival the ancients as much in the sanguinary nature of of our wars as in their frequency.

8 What war is justifiable.

After what we have said on the impolicy of war, and the moral evils which attend it, it will scarcely be expected that we should allow it to be justifiable, except in cases of necessity. Indeed we think that war can be justified only on the principles of self-defence. When a nation is invaded, or attacked in relation to her undoubted rights and principles, it is then, and then only, that she has a pretence for war. We will not, indeed, go so far as to assert, that she ought to await the attack. Whilst she takes the best methods for defending her territories at home, it is doubtless proper, especially for a maritime state, to meet the enemy half-way, and by a timely and spirited resistance, endeavour to avert those greater evils which would attend a system of pusillanimity and neglect.

In the present state of human nature, war must be regarded as a necessary evil, and as it is sometimes unavoidable, the principles and practice of it must be studied by those who are to superintend or to conduct its operations. It is this necessity that has given occasion to the art of war, the practice of which is to form the subject of the present article.

9 War considered theoretically.

Before we enter on the immediate object of this essay, however, it may not be improper to enumerate those branches of knowledge which constitute the *principles* of the military art, and of which no officer who expects to have a principal command in military operations should be ignorant. We shall first mention those sciences which should form a part of the education of every commanding officer, whether military or naval; and we shall then distinguish between those which are most applicable to the land and the sea service.

Among the first branches of a military education must be enumerated the modern languages of French and German; GEOGRAPHY, by which we would understand, not merely the description of countries, states, and kingdoms, but a knowledge of their political constitution, resources, and productions, and of the manners, customs, and character of their inhabitants; HISTORY, especially that of modern Europe, and of the Greeks and Romans. Among particular histories we would recommend those of Polybius, Xenophon, Tacitus, with the Commentaries of Cæsar, in ancient history; and Davila's account of the civil wars of France, Guicciardini's history of the Italian wars, the history of the seven years war by Frederick the Great, with a particular attention to the best histories of his own country, and of the wars in which she has been engaged. After these preliminary branches follow the rudiments of mathematics, including common and logarithmic ARITHMETIC, the elements of theoretical and practical GEOMETRY, plane and spherical TRIGONOMETRY, the principles of SURVEYING, CONIC SECTIONS, and their application to PROJECTILES; certain parts of natural philosophy, especially MECHANICS; and the principles of DRAWING plans, maps, and charts.

Besides these, a military officer should be instructed in FORTIFICATION and GUNNERY, the nature of military exercises, and the duties of the various officers attached to an army; while the naval officer should particularly attend to ASTRONOMY, HYDRODYNAMICS, NAVIGATION, the principles of SEAMANSHIP and of SHIP-BUILDING.

10 Practice of war.

There is perhaps no art or profession, in the practice of which the superiority of *example* over *precept* is more apparent than in war, insomuch that we may lay it down as an axiom, that no man can be a soldier or a sailor from theory alone. It is not from books that we are to learn the art of war, though there is no doubt that they may greatly assist and improve the skill and experience acquired in the field or on the ocean. In these active scenes have been found the great commanders, whose lives and actions are perused with so much avidity; and the only method of successfully imitating their exploits, and emulating their fame, is to encounter the dangers and the hardships to which they were exposed, and to learn how to command, by first learning to obey. A considerable share of the mechanical part of war may be acquired in a well-regulated military or naval school; but the experience necessary for a commander is to be gained only in actual service.

The practical part of war is usually divided into *military tactics*, and *naval tactics;* a division which we shall here adopt, though we have thought proper to bring the whole under one article. As the space, which we had originally allotted to these subjects, has unavoidably been reduced one half, we shall be able to give little more than a general outline, especially of *military tactics*, reserving the fuller discussion for *naval tactics*, which to a nation whose chief dependence is on her fleets, must be the most useful and the most interesting part of the subject.

It would be vain for us to attempt any historical account

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count of the progressive improvements that have been made in the art of war. Indeed this would be to repeat much of what has already been detailed under the principal historical articles of this work; for the history of nations, as it is commonly treated, is little more than a history of their wars. We might, no doubt, bring forwards much curious information respecting the offensive and defensive weapons of different ages and countries, and the character and organization of their armies; but for those and other matters of a similar nature, we may refer our readers to the following respectable authorities: Vegetius *De re militari*; Polybius's *History, with the Commentaries of* Folard; Salmasius *De re militari Romanorum*; Tacitus's *Vita Agricolæ*; Rollin's *Ancient History*; Potter's *Grecian Antiquities*; Kennet's and Adam's *Roman Antiquities*; Goguet's *Origin of Laws, Arts, &c.*; Daniel *Histoire de la Milice Françoise*; Gough's *Sepulchral Monuments*; Ascham's *Toxophilus*, and Grose's *History of the English Army, and Essay on Ancient Armour*.

At a period like the present, when the two greatest powers of Europe are struggling for glory and dominion, it will not be thought uninteresting, or irrelevant to the subject of the present article, if we offer a comparative statement of the present military and naval establishments of these two mighty empires, with a sketch of the military character of their armies; and with these we shall conclude our preliminary observations.

II
Present military establishment of the French.

According to a statement made to the French government at the commencement of 1805, the grand total of the French armies consisted of 570,964 men; viz. infantry of the line, 341,412; light infantry, 100,130; cavalry, 77,488; artillery, 46,489; engineers, 5445. Since that time, more than 100,000 have been added, and, according to the best authority, the present total does not fall short of 700,000 men *. This vast body is divided into companies for both cavalry and infantry; a certain number of companies forming a battalion of infantry, or a squadron of cavalry. The denomination of regiment is appropriated to the cavalry and artillery, while a similar body of infantry is called a half brigade. The commanding officer of a regiment is called colonel; but the commander of a large body of infantry is called chief of brigade. The names of lieutenant-colonel and major are changed for those of chief of a battalion and chief of a squadron. Those general officers which in other armies are called major-generals, are, in the French service, denominated generals of brigade, and lieutenant-generals are there generals of division.

* Edin. Review, vol. xiii. p. 455.

The corps of engineers has for its officers 8 inspectors general, 34 directors, 124 captains of the first class, 117 captains of the second class, 33 lieutenants of the first class, 21 of the second class, and 20 pupils under the lieutenants. Attached to this corps are 6 companies of miners, commanded by a chief of battalion. Each company is officered by a captain-commandant, a second captain, first and second lieutenant. Twelve battalions of miners; each battalion, containing 8 companies, forming in all 1606 men, including officers. The battalion staff is composed of a chief of battalion, an adjutant major, and an adjutant. Each company is officered by a captain, a lieutenant, and sub-lieutenant.

To raise and recruit this great military force, the French government has, since the year 1798, had recourse to one of the most tyrannical measures which was ever adopted by a despotic monarchy, we mean that of *conscription*, by which every man within a certain age, is made liable, under circumstances of the greatest rigour, to serve in the armies of the state. This system of conscription is exceedingly complex; but we are enabled, from a respectable periodical publication, to present such a summary of it as will be readily understood. France is divided into about 30 military governments, subject to a general of division and his staff, to which commissaries are attached as executive officers. The civil division consists of 122 departments; 24 of which have been acquired since the overthrow of the monarchy, exclusive of Tuscany, not included in any part of this statement. The departments are divided into districts or *arrondissements*, from three to five in number; the *arrondissements* into cantons, and the cantons into municipalities, amounting to about 55,000. Each department is governed by a prefect and his council, composed of a commissary of police, a mayor, and certain inspectors, denominated *counsellors of prefecture*; the district or *arrondissement*, by a subprefect and his council, of a similar formation. The cantons and municipalities are under the supervision of an administration, composed of the civil authorities, with a president at their head. A mayor, a commissary of police, and two officers of the government, styled *adjuncts*, are allotted to each division having a population above 5000 souls. These several authorities are in strict subordination to each other, and at the controul of the prefects and subprefects, who, themselves, are charged with a weighty and inflexible responsibility as to the military levies.

By the code *de la conscription*, all Frenchmen, between the ages of 20 and 25, are liable to serve. They are divided into five classes, from which the municipal administration draws up the lists for the ballot. These are transmitted to the prefects, by whom they are sent to the war minister, and when properly adjusted, the subprefect proceeds to the drawing of the quota imposed on each district. The conscripts drawn are formed into three divisions, the first called *conscripts for actual service*, the second the *reserve*, and the third *supplementary conscripts*. They are marched in companies of 100 men, to the places which are established as depots, where they are furnished with their arms and clothes. After this they are trained and exercised, so as to be inured to unremitting labour and fatigue.

What gives peculiar energy to the French military system, is the circumstance that their officers rise by merit and experience, and not by interest. By a law of the directory, no person (with the exception of engineers) could become officers, who had not served three years in a subordinate capacity. The revolution naturally opened the way to merit; and, seconded by this admirable policy, has filled all the posts of their army with men, who unite in themselves the qualities of the soldier, with the excellencies that qualify for command. It is not hazarding too much to assert, that nine-tenths of the present French officers have sprung from the ranks. Educated in distant camps, they know no other country, and, habituated by long devotion to the trade of war, it has become their element and their passion. Their whole fortune is staked on the sword; and their attachment is therefore necessarily secured, under the

auspicious

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auspicious influence of a leader, whose indefatigable ambition occupies them in their favourite pursuits, and whose *liberal impartiality* feeds the hope of preferment, and divides the fruits of conquest. To their credit and example is due much of that spirit, which, notwithstanding the causes of alienation hitherto observed, seems to animate the whole frame of the army; and no small share of that portentous success which has attended the course of the French arms. Of the eighteen *marechaux d'empire*, fourteen have either emerged from the ranks, or ascended from the lowest employments. Most of the generals of division, and others who hold the principal commands, have the same origin, and sufficiently prove, that war is an experimental science, and that military renown is not the prerogative of birth, but the harvest of toil, or the bounty of fortune *.

* *Ibid*, p. 431—451.

12 Late naval establishment.

We have no certain means of ascertaining the present naval establishment of the French empire, though, as it may be said to have the command of the navies of Holland, Russia, and the remains of that of Denmark, it must still be regarded as of no trifling strength. The principal fleets are indeed kept blocked up by those of Britain, in the harbours of Brest, Rochefort, Toulon, the Scheldt, and the Texel; but the escape of any of these might be the means of conveying a considerable military force to the remaining colonies, or to the less powerful allies of France. In 1791, the French fleet consisted of 73 ships of the line, 67 frigates, 19 corvettes, and 67 small craft, making a total of 226. Since that time, however, have taken place the great naval victories of Howe, St Vincent, Duncan, and Nelson, by which the greater part of *that* navy has been carried into British ports.

13 Present military establishment of Britain.

In estimating the military establishment of Britain, we shall, for the sake of more accurate comparison, first take the same period of 1805. The British land forces then consisted of 21,223 cavalry, 124,878 infantry (including 20,747 men for limited service, and 21,208 belonging to foreign and provincial corps in British pay), 89,809 militia, 8559 artillery, besides about 430,000 volunteers, making a total of 674,469. To these must be added the royal artillery, the horse brigade, the brigade of gunners and drivers, and companies of foreign artillery, amounting to 16,670, and the corps of artificers and labourers, including 704 men. Thus the whole military force of Britain, in 1805, amounted to 691,843 †.

† *Playfair's Geography*, vol. ii.

Since the passing of Mr Windham's act, this number is somewhat diminished, though our military force is now probably more effective. At the end of 1808 it stood as follows. Two regiments of life-guards, one regiment of royal horse guards, 7 of dragoon guards, 25 of dragoons, 3 battalions of riflemen, 7 battalions of foot-guards, 5 of light infantry, 176 battalions of infantry, a corps of royal horse artillery, a regiment of royal foot artillery, a corps of royal engineers, a brigade of artillery drivers, and a waggon train. The dragoons, independent of the royal life and horse guards, amounted to 19,200; the battalions of riflemen and light infantry to 8000; the infantry of the line to 149,600; the king's German legion to about 20,000; exclusive of about 96,000 regular militia, 250,000 local militia, and about 50,000 volunteers; making an effective force of about 580,000 men.

Each regiment of not more than 500 men is officered by a colonel, a lieutenant-colonel, a major, 10 captains, 10 lieutenants, 8 ensigns, an adjutant, quarter-master, paymaster, a surgeon and assistant surgeon; a serjeant-major, a quartermaster-serjeant, with 30 ordinary serjeants, 30 corporals, a drum-major and 20 drummers. If the regiment amount to 750 men, it has usually an addition of second lieutenant-colonel, a second major, 10 serjeants, and 10 corporals.

The gradation of rank among the officers of the British army is as follows. Under the king, who commands the whole as *captain-general*, is the *commander in chief*, then follow the *field-marshals*, *generals*, *lieutenant-generals*, *major-generals*, *brigadier-generals*, *colonels*, *lieutenant-colonels*, *majors*, *captains*, and *subalterns*. The different departments of the army are under the superintendence of an *adjutant-general*, a *quartermaster-general*, a *barrack-master-general*, a *commissary-general*, a *paymaster-general*, a *board of ordnance*, and a *medical board*. See ADJUTANT, QUARTERMASTER, &c.

The army of the line is recruited by enlistment; the recruits receive a bounty, and are engaged to serve for a limited period, or for life. The militia is filled up by ballot, in the several counties to which it belongs, and also receives recruits by enlistment or by proxy. Hence the British soldier, while he considers himself as the servant of the king and the state, justly boasts of partaking in the general liberty of the subject. He is protected by fixed and definite laws, against the discretionary power of his commanding officer, and is encouraged to perform his duty by the liberality of his country; and not, as in France, compelled to it by the fear of punishment. His discipline indeed is strict; but he feels none of that severe and tyrannical coercion which seems to be the first principle of motion in the armies of Napoleon.

14 Naval establishment.

In its naval establishment, Britain justly boasts of being superior to every nation in the world. The number of her fleets, and the courage and discipline of her seamen, have given her the unrivalled dominion of the seas, of which it would be difficult for the whole combined navy of Europe to deprive her. In 1809, the naval force of Britain consisted of 157 ships of the line, 19 from 50 to 44, 184 frigates, 181 sloops, 308 brigs, making a *total* of 849 in commission; besides 56 of the line, 12 fifties, 56 frigates, 44 sloops, 24 brigs, *total* 192 in ordinary and refitting; and 50 ships of the line, 20 frigates, 20 sloops, 10 brigs, *total* 100, building: making a grand *total* of 1141.

The progressive advance of our navy will appear by attending to the following recital of its tonnage at different periods, from the reign of Henry VIII. to the present time.

	Years.	Tons about
At the death of Henry VIII.	1547	12400,
Edward VI.	1553	11,000
Mary,	1558	7000
Elizabeth,	1603	17,000
James I.	1625	19.000
Rebellion,	1641	22,400
At the death of Charles I.	1649	uncertain.
At the Restoration,	1660	57,460
At the death of Charles II.	1685	103,558
Abdication of James II.	1688	101,900

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	Year.	Tons about
At the death of William III.	1702	159,000
Anne,	1714	167,170
George I.	1727	170,860
George II.	1670	321,200
31st December,	1788	413,660
	1806	776,000
	1809	800,000

It appears, however, that notwithstanding the vast increase of our navy, not a single dockyard has been added to it since the reign of William III. about 109 years ago, at which time the tonnage of the naval force of this kingdom amounted to nearly 160,000 tons; it is now nearly 800,900 tons, or about five times as large *.

* *Statement by Lord Melville.*

In sketching the military character of the French and British armies at the commencement of the 19th century, we shall avail ourselves of the observations of an anonymous, but able and apparently impartial publication, which appeared soon after the peace of Amiens, entitled *The Military Character of the European Armies at the Peace of Amiens.*

15 Military character of the French army.

The astonishing success which has attended the French arms on the continent of Europe, is to be attributed partly to the regular organization and severe discipline established by the *Code de la Conscription*, but it is still more to be ascribed to the skill, experience, and activity of their officers. The French generals early discovered the advantages resulting from dispatch. The alertness of the soldiers, the lightness of their baggage, and their inattention to regularity in time of action, enabled them to execute their movements with a celerity which has frequently ensured success. In an open country, lines could not be preserved without difficulty. The French armies were therefore formed in columns. Brigade succeeded brigade, and when one division was repulsed, and fell back on the columns in the rear, those in their turn attacked the enemy, or sustained his shock, and fresh troops perpetually came forward, to supply the place of those which had been defeated.

The French battalions have no field-pieces attached to them; but this want is amply compensated by their flying artillery, which is composed of the flower of the French soldiers, and by its boldness and rapidity of movement, supplies the place of that large train of artillery with which the other European armies are usually burdened. It is a constant maxim in the French armies to have a body of reserve, composed of their best troops, and under the command of an able general. If the main body should be beaten, the reserve covers their retreat, and on more than one occasion it has snatched the victory from the hands of the enemy.

The French generals, like rich and bold gamesters, are incessantly tempting fortune. They look upon their losses as nothing, provided they succeed in the end. The little value at which they estimate their men, the certainty of being able to replace them, the personal ambition of their chief, and the customary superiority of their numbers, afford them an advantage which cannot be counteracted but by great skill, conduct and activity.

16 Military character of the British army.

The soldiers of Britain are as intrepid by land as her sailors by sea. Their want of success on the continent cannot be ascribed to their want of bravery, but rather to the organization of the British armies, their inferiority of numbers, or the inexperience of the officers by whom they are commanded. Most of their commanding officers, instead of conforming to general regulations, follow their own particular plans and ideas, according to their several geniuses, acquirements, and prejudices. In a nation, which, from the spirit of its constitution and the habits of its people, is formed rather for naval than military operations, a ministry, however enlightened, scarcely possesses that authority which is necessary to give uniformity to the different departments of the army, to constitute a regular and corresponding whole, and to surmount those obstacles which are thrown in the way of all uniformity of military system, by the distance and distribution of the troops. The small numbers in which British troops are generally compelled to act on the continent, and their mixture with those of other nations, to which they are sometimes even subservient, are circumstances extremely disadvantageous.

In a military life, good faith, honour, and courage, are the principal qualifications, and these are eminently conspicuous in the British army. Their military ardour is greater than what is seen in any other service, but this is in a great measure damped among the officers by the difficulty of promotion. Interest with ministers, and the necessity of raising money to defray the expences of the different departments of the state, though far from being the most equitable, are here unhappily among the first means of military promotion.

The soldiers of the British army are possessed of elements to enable them, under a commander of abilities and officers of experience, to be the best troops in the world. They require neither brandy nor self-conceit to make them brave; their courage is innate; it is a national instinct. Their officers too usually possess much greater information on general topics than those of all other European nations, as education is more cultivated in Britain than elsewhere. They are attached to their profession, and follow it rather from generous motives and military spirit, than like mercenaries from a view of interest and profit.

On the political and moral principles of war, see Cicero *De Officiis*, Grotius *De Jure Belli et Pacis*, Puffendorff's *Law of Nature and Nations*, and Machiavel's *Discorsi*; and on the principles of war considered as a *science*, see a *memoir* by Maizeroy, in the 40th volume of *Histoire de l'Academie des Inscriptions et Belles Lettres*, and Folard's *Commentaries on Polybius*.

PART I. MILITARY TACTICS.

27 Nature and object of military tactics.

Some writers on the military art distinguish *tactics* from what they call *strategy*; understanding by the latter the science of military movements when not in sight of the enemy, or at least out of the range of their shot; while they describe the former to be the science of military movements in sight of an enemy, or within the range

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It is not possible for us, within the very scanty limits to which we are now reduced, to give any thing like a regular treatise on the military art. We shall therefore endeavour to select the most useful and interesting topics, and supply the place of disquisition by numerous plates with appropriate explanations.

The science of military tactics comprehends the disposition and arrangement of troops, whether on marches, in camps, or in line of battle; the attack and defence of posts; the construction and superintendence of the works by which they are to be defended; the conducting of sieges; and the defence of besieged places. These are the principal operations of a soldier, and these we shall briefly consider nearly in the order in which we have enumerated them.

18 Of directing the march of an army

To direct the march of an army is not one of the least difficult parts of a general's duty. To do this with ability, he must be well acquainted with the nature of the country through which his troops are to pass, with the obstacles which are likely to oppose them in their progress, and with the disposition of the inhabitants. Our business here is only with the first of these considerations. There are three descriptions of countries which may become the theatre of war; an open country intersected by rivers, a mountainous, and a woody country. The march of an army through the first, as far as respects the face of the country alone, is seldom difficult, except in the passage of rivers, which we shall consider by and bye; and the last description of country is now so uncommon in Europe, that we need not dwell on it. A mountainous country, however, presents numerous difficulties to call forth the abilities and experience of a commander, as in such a country, not only are the roads winding and difficult of access, but the unevenness of the ground, and the intervals between the hills, render it very easy for an enemy, with a small force, to oppose and distress a numerous army.

19 through a mountainous country. Plate DXLIV.

The plan in Plate DXLIV. is intended to illustrate the march of an army through a mountainous country. At A is shown the position of the army previous to its march, with the artillery and baggage P, drawn up under their proper escorts, in front of the camp. At B are parties of hussars constituting the advanced guard of the army on its march; and at C are parties of infantry forming the advanced guard of the columns in which the army is disposed. D represents the infantry forming the head of the columns; E the park of artillery and waggons attached to it; F, battalions of artillery, G the cavalry, H the baggage of the army, and I their escort. At K are parties of hussars and at L parties of dragoons. M represents the infantry of the reserve forming the rear guard, and N platoons of infantry sent forward upon the heights, to cover the flanks of the principal columns. At O are villages in front of the position where the army is to encamp, and which have been taken possession of by the light infantry.

The number of columns into which the marching army is to be divided, will depend on the number of roads or accessible approaches that lead to the position which it is to take up. In the present case there are only two principal roads, each leading across the river, and winding through the valleys to the principal heights, so that the army must march in two divisions. The usual disposition of the columns is as follows. Four or five brigades of infantry, according to the number which composes the army, should be placed at the head of each column; the same partition should be made with regard to the artillery, which must follow the infantry; the cavalry must march next, and the baggage of each column, well escorted by infantry, must follow the cavalry, then the rest of the corps of light horse which are not detached; and the dragoons are placed the last, in order to dismount, and sustain the rear-guard in case it shall be attacked.

20 Of the passage of rivers.

An army seldom proceeds far without encountering a river in its march, and as it commonly happens in a country which has become the seat of war, that the bridges are destroyed or rendered impassable, the army must cross the river, either by swimming, at some ford, or by temporary bridges thrown over for the purpose. It is most advantageous to cross a river at some part where the stream is divided by small islands, unless the river be so shallow that it may be easily forded. If it be necessary to construct a bridge, this is best done by means of boats or pontoons, and all the necessary apparatus should be ready at the place of crossing at an appointed hour, and every measure should be taken to avoid confusion, and to be prepared for the enemy, who will probably dispute the passage. The two heads of the bridge when constructed should be entrenched, and well furnished with troops, and, if possible, the islands in the neighbourhood should be fortified by proper works, to prevent the enemy from destroying the bridge, or incommoding the labourers employed in its construction.

If the river be narrow, it is best to cross at some place where it makes an angle, especially if, as commonly happens, one of its banks be higher than the opposite bank, so that the higher ground may be defended by a battery. If the river be fordable by infantry, care should be taken beforehand to clear the bed at the ford, and render the banks easy of access.

Plate DXLV. fig. 2.

The lower figure of Plate DXLV. illustrates the passage of a river. AAA represent bridges of boats; B, redoubts by which the bridges are protected; C, a battery, under cover of which the infantry work at the construction of the redoubts; D, a battery, to prevent the enemy from annoying the army on its march; E, the march of the army; F, the artillery distributed among the brigades of infantry; G, infantry forming in columns to open on the opposite side through the intervals of the redoubts; H, march of the columns in the front of the redoubts, where they halt to give time for a part of the cavalry to form upon its flanks; I, a battery erected to facilitate the forming of the cavalry; K, cavalry, which in gaining the opposite shore, forms in order of battle, and posts itself upon the flanks of the infantry; L, eight battalions in column upon the right wing of the army, to go and examine the village and attack the enemy in it, in case he should be possessed of it; M, hussars and dragoons, who have taken possession of the height which is on the left wing of the army; N, a brigade of infantry posted next the height, covering the left wing of the cavalry; O, the disposition of the army marching up to the enemy.

It is in general a very difficult task to defend the passage

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sage of a river against an army that is determined on crossing it. Indeed, if the river be of such a nature as to present several points by which an enemy can cross, and if the defending army be not of such strength as to meet their opponents in the field, such a defence will be almost impracticable. Where it can be attempted, however, and where sufficient notice can be procured of the enemy's approach, all the boats and barks found on the river should be removed or destroyed, to prevent the enemy from using them in constructing his bridges. Both banks of the river should be carefully reconnoitred, that the fords and other accessible points of passage may be sufficiently obstructed; and the ground which might protect the enemy's passage, should in particular be attended to. Roads sufficiently wide to admit of many columns, should be made along the side of the river to be defended, that a great number of troops may be advantageously disposed. It must be confessed, however, that if the accessible points extend along a considerable tract of country, and if the bank of the river next the enemy overhang that on the opposite side, a defence will be nearly impossible.

21 To defend the passage of a river.

Fig. 1. The upper figure of Plate DXLV. shews the manner of disposing the troops to defend the passage of the river. A, the march of the main army in three parts to defend the river; B, the camp of the light horse, infantry, and dragoons, on the wings of the army; C, castle and village, guarded by light infantry; D, a town occupied by the infantry belonging to the army; E, bridge broken down; F, islands occupied by infantry; G, posts of infantry distributed along the side of the river; H, batteries established along the side of the river; I, posts of cavalry, to keep the communication between the camps; K, bridges constructed to preserve the communication of the islands; L, bridges for the communication of the camps.

22 Basis of modern military operations.

Modern warfare is distinguished from that of the ancients, not more with respect to the arms which it employs, than the multitude of stores, ammunition, and provisions necessary for a campaign. The number of horses now employed for drawing the artillery, and the ammunition waggons, as well as to mount the great increase of cavalry, considerably adds to the quantity of military stores required by the troops. This has produced the necessity for magazines, established in such number, and at such distances from each other, as may most expedite the operations of the campaign; and these magazines require not only to be fortified themselves, but to be strengthened by forts or redoubts in their vicinity. To these magazines modern writers on the art of war have appropriated the term of *basis of military operations*, and the roads by which an army receives its subsistence from the magazines, are called *lines of operation*. The situation of the principal magazine, and the length and direction of the lines of operation, are considered as of the highest importance. With respect to the first and second of these, we must refer to Templehoff's History of the Seven Years War, where the question is considered with great minuteness and scientific accuracy. The direction of a line of operations may be illustrated by the first seven figures of Plate DXLVI.

Plate DXLVI. fig. 1. Fig. 1. represents a line of operation forming the segment of a circle, having a line of posts ACB towards the enemy's country, and two principal fortresses DE within the segment. As this circular segment is supposed to surround a part of the enemy's territory, and is strengthened by the two fortresses AB, at the extremities of the basis, it is esteemed the most advantageous form. On the other hand, if the segment had its circumference directed towards the enemy, as in fig. 2. it would form the worst possible direction for a basis; for here the fortresses CD, placed in the circumference, are very much exposed, and might be easily taken by detachments from the columns E and F. The only way of preventing this would be to detach troops from A and B laterally, to incommode the columns E and F, and to take up a strong position either at g or h. The more the segment approaches to the elliptical form, as in fig. 3. it is the less susceptible of defence, as is evident from the relative position of the three fortresses A, C, and B. Fig. 2. Fig. 3.

Fig. 4. The line of operation represented by fig. 4. consisting of salient and obtuse angles, such as A c B, B d G, constitutes an excellent form, as it resembles the outworks of a fortress, and it is as impracticable for an enemy to enter into the interior of this basis, as to carry a curtain between two flanks. The two fortresses $c\,d$ are not nearly so much exposed as C in fig. 3. as if one of them were attacked, it would be easy to make a diversion from the other into the enemy's country. If the points which terminate the basis advance as in fig. 5. it will be a favourable circumstance, especially if the most advanced post were bounded by the sea, or by a large river. Fig. 5.

Fig. 6. The basis which we have been considering consists of curved or angular lines. Now, let us suppose two bases, the one A h B, fig. 6. forming merely a straight line, while the other $c\,e\,g\,d\,f$, has two of its lines $e\,c$ and $d\,f$ advanced towards the enemy. This latter is the more advantageous, as it exposes so much more of the enemy's country. In general, it is a good rule to construct fortresses opposite to those of the enemy, as here the fortress g, if moderately strong, is capable of protecting the whole line from e to d, against the three opposite forts A h B. It is a great fault for any part of a basis to recede, as $d\,c$ from the line of the enemy AB, fig. 7. so as to form an angle with it, as here all the country between A and c is exposed to the hostile attacks of A and B; but, if the line were parallel to that of the enemy, as $d\,e$, it would be a good position. Fig. 7.

23 Establishment of camps. Next to the establishing of magazines, and providing for their security, and that of the lines by which they are connected, it is of the highest importance for a general when he takes the field, to select the proper positions where he may encamp his army, so as to be readily defended against the attacks of a superior enemy, and have an easy communication with his own posts. In selecting such a situation he must be guided partly by the nature of the country, and partly by the situation of the enemy; but if possible, he should choose a position which is rather elevated, and which may be protected on the flanks or rear, either by the natural situation of the ground, or by works thrown up for that purpose. It should not be too near the bank of a river, though it may be of advantage to have such an object in front. The encampment of an army in such a situation is pointed out by Plate DXLVII.; where A is the camp of the main body of the army; B, an advanced camp, composed of dragoons and hussars, in order to cover the right of the army, to guard the passes by which the enemy might make incursions upon the flanks and rear of the army, molest the convoys, and cut off the communications

Plate DXLVII.

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nications; C, villages and bridges, guarded by the light infantry; D, posts of dismounted dragoons in the front of their camp; E, posts of dragoons on horseback, to secure the communication between their camp and that of the main body of the army; F, bridges built to keep up the communication between the grand and the advanced camp; G, bridges and villages guarded by detachments of infantry; H, grand guards of horse; I, guards of infantry; K, bridge, village, and mill, guarded by the infantry belonging to the army; L, camp of dragoons and hussars, covering the left of the army, and supporting the light infantry; M, villages and bridges guarded by the light infantry; N, posts of dismounted dragoons in the front and on the flanks of their camp; O, posts of dragoons on horseback; P, posts and detachments of hussars, to patrole in front and on the flanks of the army and their camp.

24 Intrenched camp.

It often becomes necessary, either from an inferiority of numbers, or from the nature of the ground, to intrench or fortify a camp. In general this is done by digging deep ditches round the most defenceless part; driving pallisades in front of this ditch; forming an embankment of felled trees, with their unlopped branches pointing towards the enemy; or, where there is time for such an operation, and where the proper materials can be obtained, constructing redoubts or regular outworks, capable of being defended by artillery.

Plate DXLVIII.

Plate DXLVIII. represents a camp intrenched in an open country, without any peculiar advantages of defence. A, the main body of the army encamped behind its intrenchments; B, the camp of the troops of reserve; C, camp of the dragoons, to secure the rear of the army; D, camp of hussars, to cover the ground on the right of the army; E, villages and redoubts guarded by the light infantry to secure the camp of the hussars; F, bridges built to secure the communication of the army with the ground on the right, and to favour the retreat of the troops posted on the opposite side; G, brigades of artillery distributed on the flanks, and along the whole front of the army; H, the park of artillery; I, a bridge intrenched, to secure the communication between the army and the ground on the left; K, villages and farm houses, guarded by detachments of hussars and light infantry, to patrole in front of the army.

Plate DXLIX.

Fig. 1.

In Plate DXLIX. are shown other methods of intrenching a camp in the neighbourhood of a town or village, and in situations where the camp can be protected by inundations. Fig. 1. represents an intrenched camp in the neighbourhood of a town. A, a deep marshy valley, with an unfordable rivulet across it. B, a redoubt constructed on a mountain, by which the right wing is *appuyed*. C, a small wood in front of the mountain. D, a line which connects two fleeches together at the foot of the mountain, where the village of Weilheim is situated. E, a rivulet, over which are thrown bridges of communication, to facilitate an intercourse between the camp and the redoubt on the hill. F, an eminence with a gentle declivity, at the foot of which is the village of Mansfeld, surrounded by defiles and hollow roads. G, defiles and hollow roads. H, lines which run along the circumference of the heights about Weilheim, forming a retrenchment. I, close works. L, a redoubt which masks the entrance into Stemmern. M, a small wood, cut down in order to have a full view in front of Stemmern. N, a thick wood which covers some high mountains by which the left wing is supported. O, an abattis which is made across the wood for greater security. P, infantry pickets. Q, a redoubt on a small eminence, constructed for the purpose of covering the opening behind the left wing of the camp. R, a line of communication from the last redoubt to the left of the intrenchment. S, several passages 30 feet broad and closed in by chevaux-de-frize, to afford an opportunity for the cavalry to advance, should the enemy be foiled in his attack against any part of the works. T, the infantry and cavalry encamped behind the retrenchments; the infantry in the first line, and the cavalry in the second. U, X, Y, Z, four roads behind the camp to facilitate the retreat of the army, should it be pressed.

Fig. 2, 3.

Fig. 2. and 3. represent an intrenched camp with inundations in front. Fig. 1. *a b*, two dykes 40 paces long, 5 broad, and as many high. CD two rows of stakes from 4 to 5 inches thick. E, the coffin formed by means of stakes filled up. It is eight feet broad. F, the adjacent country, inundated by the rivulet being forced out of its current by the last dyke and by *a* and *b*. G and H, the outlets which the rivulet seeks, to continue its course. I, small creeks or ends of ditches dug about the ground. Fig. 3. represents the current of a rivulet, with a dyke to occasion inundations. Camp, with the several dykes in front, which are calculated to produce inundations. The spaces between these dykes are called coffins, viz. 1, 2, 3, 4, 5.

25 Construction of redoubts.

We have mentioned the works by which the field posts are fortified, and which are usually called *redoubts*. As the construction of redoubts is generally a work of the moment, and falls within the province of the commanding officer of a detachment, it is proper that we should here describe the most useful and expeditious methods of raising such works. These methods are illustrated by the plans in the upper part of Plate DL.

Plate DL Fig. 1.

Fig. 1. shows the plan of the ordinary square redoubt which is constructed in the following manner: When a proper spot has been chosen, a line *a* AE is drawn of a sufficient length, and at one extremity *a* is drawn *a* C perpendicular to it. Then from *a* towards C and E are set off the dimensions proposed for each side of the parapet within the fort, allowing 2 or $2\frac{1}{2}$ fathoms for 30 men, 4 fathoms for 50, and so in proportion for a greater number. These lines being ascertained, a picket is placed at C, with a cord attached to it, and with the length *a* C is described an arch, and from the point E, with the same distance, another arch is described, intersecting the former in F. Then joining EF and CF, the square forming the inner parapet is completed. Within the square, at the distance of 2 or 3 feet, is described another square I, L, M, N, having its sides parallel to those of the former. This marks the breadth of the banquette, where the men are to be drawn up. Again, on the outside of the first square at about 8 or 9 feet distance is drawn a third square O, P, Q, R, determining the outer side and thickness of the parapet. This thickness is only calculated to resist musket balls; as, if it is to stand against cannon, it should be at least 18 feet. Lastly, at rather a greater distance from this third square is drawn a fourth S, T, V, X, marking the breadth of a ditch that is to surround the redoubt. The

Military Tactics. The lines being finished, *fascines* or faggots of brushwood are to be laid between the two innermost squares, as a foundation to support the earth of the banquette; a second range is laid on the lines AB, GH, to support the inside of the parapet, and a third on the square O, P, Q, R, to strengthen the outside of the parapet, leaving a space through all the *fascines* to the ditch, on the side least exposed to the enemy, as at B, for an entrance. It is sometimes convenient to make this entrance take a winding direction, as is shown at T, fig. 2.

Fig. 2. Fig. 3. Fig. 3. exhibits a section of these works, where AB is the breadth of the ditch at the top; MN its breadth at the bottom; FN its slope, on a line with the outside of the parapet, called the *scarp*, and GM its slope towards the open country, called the *counterscarp*. AL and ID represent the *fascines* forming the outer and inner slopes of the parapet, the interval between them being filled with earth trodden down hard. At E is the banquette. DC is the thickness of the parapet below, and IL its thickness above, which forms a slope for the more convenient firing of musketry.

In this square redoubt it is evident that the men must fire straight forward in lines perpendicular to the sides of the squares, as in fig. 4. As it is often of great consequence that the directions of firing should cross each other, the better to flank the enemy, the banquette is sometimes formed with angles, as in fig. 5. so that the men may stand two together in little *redans*. As, however, such a construction takes up too much time and labour for ordinary occasions, M. Le Cointe prefers a circular redoubt, such as is represented at fig. 6. where the men may fire from every part of the circumference. The construction of such a redoubt is extremely simple, and differs only in its first step, viz. describing the concentric circles, which is done with a cord fastened at one end by a picket at a central point C.

Fig. 4. Fig. 5. Fig. 6.

The strength of the redoubt will be much increased, if the ditch can be filled with water, as by turning into it the stream of a rivulet. See Q, fig. 7. If the ground be uneven, so that the water will not run equally into every part of the ditch, dams must be raised, as C, to keep up the water in the higher parts, whence it may run to the lower, after the former are full.

Fig. 7. Fig. 7. represents a plan of the square redoubt, with a wet ditch, when completed. A, the inner ground of the redoubt; B, the bottom of the ditch; CDE, the dam of earth; F a dam of boards, planks or fascines; G the upper part of the redoubt, made with fascines or with earth thrown out of the ditch; H, the lower part of the redoubt cut into the earth; I, the berme or space left at the outer bottom of the parapet, to keep up the earth; L, the entrance of the redoubt; M, the inside of the parapet; N, the outside of the parapet; O, the banquette; P, the glacis; Q, the river introduced to fill the ditch with water.

26 Of detachments sent to attack or defend a post.

The attack and defence of posts are among the most important departments of what the French call *la petite-guerre*, and in a country where fortified towns are rare, constitute a considerable part of field operations. We shall consider them rather more at large than we have the preceding parts of military tactics.

When an officer is detached either to attack or to guard a post, he should provide himself with a cord regularly divided, for the purpose of describing lines, and raising temporary works, and should procure a skilful and confidential guide, from whom he may derive the requisite information respecting the nature of the country, and the breadth and goodness of the roads. He should dispose his party in such a manner that an advanced guard of cavalry, as A, fig. 8. Plate DL, should set out first, preceded by a small detachment of about six horsemen, headed by a corporal, as B, C, C; two horsemen in the middle, and two on each side. While the main body is moving along the principal road, as from H to F, a detachment of about 8 or 12 horsemen, according to the strength of the corps, should be sent about 50 paces on each side, by way of wings, as DD; and from each of these wings 2 men should keep 50 paces farther out, as at EE, by which means the country will be properly examined, and surprises from the enemy prevented. On coming near a wood, as at NN, the cavalry should spread, the better to scour the outskirts and the wood itself. When the corps is numerous, the cavalry should be formed into squadrons, as G, G, G, and the infantry into platoons, as F, F, F, marching alternately along the road.

Fig. 8.

If, on the march, the advanced guard come to a cross road, or the entrance of a hollow way, as at I, I, where it is likely they may be met by a party of the enemy, they should immediately prepare for an attack; and if the commander of the main body observe his advanced guard in action, he should immediately draw off his platoons of infantry, and form them on the side of the road, as at L, L, L, or on some neighbouring height, as at M, M, that they may be out of the way of the enemy's cavalry, and ready to engage if occasion should require it.

On the march the party should carefully avoid villages, and rather halt or refresh his men in a wood, or some other concealed spot.

27 On reconnoitring.

The commander of a detached party must take the safest and most effectual methods to reconnoitre the country through which he is to pass, without being observed or suspected by the enemy. The method of doing this recommended by M. Jeney will frequently succeed, and is as follows: He supposes himself with his party at Soest in Westphalia A (fig. 2. Plate DLI), and the enemy posted at Bervick B, two leagues from him. To know the situation of this place without stirring from Soest, he takes the map of the country: and from Soest as the centre, he draws a circle, whose circumference passes half a league beyond Bervick. He draws a circle of the same size upon a leaf of paper, to make his plan, as in fig. 2. and then places Soest in the centre A, and marks all the villages which he finds in the map near the circumference upon his plan, with the distances and bearings as they are represented in the map, making use of a pencil to mark the places DDD, so as to correct the errors more easily which the map may have led him to make.

Plate DLI. fig. 2.

Having thus formed his plan with a scale of two leagues, he goes to the burgomaster of the town of Soest, where he causes some of the most intelligent inhabitants to come, and speaking to them freely and openly, induces them to communicate all the information for which he has occasion.

The better to conceal his designs, he begins his reconnoitring by Brockhusen, a village distant from the enemy. He asks the distance from Soest to Brockhusen;

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sen; if they say it is a league and three-fourths, he corrects the distance of his plan, which made it two leagues; then he informs himself of all that is to be found on the road from Soest to Brockhusen, chapels, houses, woods, fields, orchards, rivers, rivulets, bridges, mills, &c. If they say that a league from Soest they pass the village of Kinderking, he marks that place upon his plan. He asks if the road from Soest to Kinderking be crossed by any other road; if there be any morass or heath; if the road be inclosed, paved or straight; if there be any bridges to pass, and at what distance. He takes care to mark every thing on his plan, forgetting nothing, even to mills, bushes, gibbets, gullies, fords, and every thing that can be got from their information; which will probably be perfect, because one always knows more than another. He continues his questions from Kinderking to Brockhusen, and advancing by little and little, observes the same method on the roads of the other villages round, marked DDD. In this manner he cannot fail to acquire an entire knowledge of all the places; besides, he finds himself imperceptibly instructed in the position of the enemy, by seeing the different routes by which he can approach with the greatest security.

28 Attack of posts.

For the attack of an enemy's post, such men should be selected as are brave, cool, and experienced; or if the affair require a considerable number, the detachment should be divided into platoons, some composed of picked men for the real attack, and others of ordinary soldiers for feints. The men should be provided, besides their arms, with such instruments as may be necessary for pulling down or scaling the enemy's works, such as shovels and pickaxes for fascine parapets; hatchets for pallisadoes or chevaux de frize, and scaling ladders for stone or brick work. Having made the proper disposition for his attack, and procured the necessary guides, the commander of the detachment should set out in the night, so as to be at the place of attack two or three hours before daybreak, taking care to march with as little noise or parade as possible.

If the post to be attacked be an ordinary redoubt, such as we have described in N° 25. on hearing the signal previously agreed on, all the divisions are to rise at once from the place where they should have lain concealed; the first ranks should leap into the ditch, and soon after the second should follow, and both together assist in undermining the angles of the scarp, or cutting away the stakes which may impede their progress. If the parapet be faced with stone or brick work, care should be taken that the ladders be not too short, and great expedition should be used in mounting them, and especially in following the leading men in the assault, if they should be knocked down by the fire of the enemy.

Should the ditch be filled with water, and too deep to be waded, it may be crossed on temporary bridges made of planks, supported on empty casks, or the ditch may be filled up with casks full of earth. If, as often happens, the ground be obstructed with caltrops, these must be swept away by dragging trees with their leaves and branches over the ground (A).

In attacking posts of considerable magnitude, such as villages, it is best to divide the attack, and to make a feint on those parts which seem best defended, while the true attacks are reserved for those situations which seem most difficult of access, and where consequently, the enemy is least upon his guard. As soon as part of the village has been carried, some divisions of the detachment should hasten to strengthen their position, by possessing themselves of some church, or high ground, from which they annoy the enemy.

29 Defence of posts.

When a post is once occupied, if it be thought of sufficient consequence to retain it, the best methods should immediately be taken to protect it against an attack of the enemy. The infantry to remain under arms in the middle of the place, the cavalry to patrole without, while the commanding officer, escorted by a dozen horsemen, goes to examine the environs to make his arrangements; having sent several small detachments before, to cover him in time of reconnoitring.

Having remarked the places proper for his guard, defence, and retreat, as well as the dangerous ones by which the enemy can make approaches secretly to surprise him, he should choose the most convenient in the front of his post to fix his grand guard D, (fig. 1. Plate DLI.), which must face the enemy. He must mark the heights for this guard to place their vedettes EEEE, and regulate the number according to the exigencies of the situation. In a covered country you must not be sparing of them, and must reinforce every guard. At 50 paces from the front of the grand guard a non-commissioned officer with eight horsemen should be always ready to set out at K, to go and reconnoitre, when the vedettes have observed any party.

Plate DLI. fig. 1.

If the post to be defended be merely a redoubt, it will be proper to keep in readiness a number of trees cut down with their branches, to stop up any breaches made by the enemy's shot. The men employed in the defence should stand in three ranks, the front and centre ranks with fixed bayonets, and the third rank provided with long pikes, so as to project as far as the bayonets of the front rank. On the enemy's approach, the men should reserve their fire till the enemy come up to the glacis, and the rear rank should be furnished with hand grenades, or lighted faggots, to throw among the enemy, when they attempt to scale the parapet.

In the defence of a village or small town, guards should be posted at the entrance of the principal streets; trenches should be cut across the streets, and cannon planted behind them, while a detachment of cavalry should occupy the market-place, or broadest street, to attack the enemy, if they force an entrance. If the advanced guards are driven in, they should retire with coolness and deliberation, defending their posts from house to house, till proper support can be given them from the body of the detachment.

If there be any dangerous place capable of covering the approaches of the enemy in the environs of the post, and

(A) The principal engines employed in the attack of posts, are represented in Plate DLV, to which we shall presently refer.

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and out of the circuit of the patroles, there should be a guard placed there, more or less strong according to the importance of the place, and care should be taken to preserve the communication. The guards and picquets being placed, the detachment that was sent out on the roads must be called in, and then go to work to lodge the party in the gardens that open upon the country, and the commanding officer's quarters; beating down hedges, filling up ditches, and levelling a piece of ground large enough to draw up the whole corps. The horses to be put under cover in barns, contiguous to the gardens; but in case there are no barns, they may substitute sheds open on one side, that the horses may go out together in case of an alarm. The officers should occupy the houses in the neighbourhood of the sheds, and one of each company remain day and night with the company, to prevent any of the men from entering the village without leave, upon any pretence. The commanding officer must acquaint the officers of his having chosen the place M for the rendezvous in case of a retreat; which ought to be at some distance from the village, and on the side he judges most convenient for retiring to the army. At sunset the grand guard are to return to the post and join the picquet, the half of each to mount alternately till daybreak, and then the grand guard to return to the place which they possessed the day before. The sentries and vedettes should be doubled, and all the passages shut up with waggons placed in two rows, except one for sallying out at in case of a retreat, made wide enough for the passage of the patroles or the whole cavalry.

The corporals of the ordinary guard should lead the relief of the vedettes every hour, setting off together; but when they come to the passage of the post A, they must separate into two parties, the one to the right to relieve the vedettes BBB, the other to the left for the vedettes CCC; then each of them, with the parties they have relieved, should go on at their head a quarter of a league by the two routes pointed out in the plan, to examine the environs, supposing an hour to each. Besides this reconnoitring, the captain of the grand guard should send two patroles in the night. To fill up the intervals, they should set one about half an hour after the corporals, and make the same round.

30 Mode of fortifying villages.

In defensive operations in an open country, the fortifying of a village or a church-yard may often prove of importance, as such posts well defended may obstruct the movements of the enemy, and give time for a sufficient force to collect to meet them in the field. We shall therefore describe the most approved mode of strengthening these positions.

When it is proposed to fortify a village, inquiry should first be made respecting the surrounding country, whether there are woods, hills, or rivers near the village, whether the roads be accessible, whether provisions can be easily obtained, &c. If the village is to be occupied as a post of defence merely, the woods, rivers, ravines, or heights, may afford advantageous outposts or situations for batteries or ambuscades; but if it is to be possessed as an advanced post on the eve of a battle, the woods next the army should be cut down, the hollows filled up, and every thing removed which may obstruct the freest communication between the village and the main army; while on the side of the enemy, every obstruction by works, trees, &c. should be thrown in the way of his approach. The roads should be broken up or intersected with deep ditches.

If there be good hedges or deep roads parallel to the village, or in such a situation as to front the enemy, these will serve as breastworks, and for shelter. The hedges should be cut down to within four feet of the bottom, their tops sloping towards the country, and deep ditches should be dug in front. If the roads are deep, *banquettes* or *steps* must be thrown up next the hedge to raise the men to the proper height for firing. For want of such natural means of defence, it will be necessary to throw up intrenchments on the side next the enemy and on the flanks.

Plate DLII. fig. 1.

Fig. 1. Plate DLII. will explain the method of doing this in a village, under ordinary circumstances. The village stands in a plain, and in front of the army, which is distant from it about 600 paces, *a*. The front of the intrenchment consists of three fleeches or arrows, *b*, *c*, *d*, joined together by lines. There are wolf-holes before the works that cover the left flank *e*: the line *g*, which crosses some swampy grounds, is broken in several places *i*; and the grove of wood *l*, is cut down, to prevent the enemy from approaching under cover of it. As the right flank, consisting of a level plain, is more exposed than any other quarter, in addition to the works made of earth, which are thrown up at *m*, trees are collected, and heaped up in the form of an abattis, *n*. These are defended by a discharge of musquetry from the intrenchments, whose lines are raised as high as possible behind the growing hedges *o*, which inclose the gardens. It has however been judged necessary to throw the works up in a forward position *p*, and to have an interval between them and the hedges, lest the houses should be set on fire by the enemy, and the troops be exposed to it. Every thing is left clear and open at the back of the village, in order to secure a free intercourse with head-quarters.

Other measures, however, must be adopted in the fortifying of villages which lie at so great a distance from the camp, that the enemy might surprise and take possession of them before any succours could be sent; for in that case, intrenchments must be thrown up throughout the whole of their circumference. If, on the contrary, one of the wings of the army should be supported by such a post, it would be more judicious to put the flank in a state of defence, and to lengthen the works in that quarter, to prevent the enemy from turning it.

If it should be judged expedient, under the circumstances of the army being cantoned, to fortify a village which lies in a plain, other means must be used; for in that case there would not be troops enough to defend it. Should there be a sufficiency of men, intrenchments must be thrown up in the manner we have described, and fleeches must be adopted to cover them behind, with lines to connect the vacant intervals; but if there be a scarcity of soldiers, nothing but what is absolutely necessary must be done; for it is highly impolitic to attempt more than can be easily defended. Under these circumstances you must be satisfied with erecting small works, or using barricadoes to mask the entrances; here and there likewise fleeches must be constructed, whose communication will be kept up by the garden hedges. If the village should stand on an eminence, it may

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may be fortified with more facility, and many things may be omitted, as the natural situation is itself a respectable post.

Should there be a very great disproportion between the extent of the village, and the number of men intended for its defence, and the latter should be too small, a part only must be fortified, and the remainder of the houses must be secured by lines. Sometimes indeed it is found necessary to burn or destroy them, to prevent the enemy from approaching the fortified parts, under cover of the buildings.

But if the garrison should not be sufficiently strong even to defend a part of the village, you must be contented with fortifying the church and church-yard, or the castle if there be one. If any of these posts be thought defensible, troops must occupy them on the first alarm; but this must be done in perfect safety, and without the soldiers being exposed to be cut off on their march. This precaution is above all others necessary where villages are so long and open that the cavalry may enter them at every opening. On this account the ordinary roads and avenues must not only be obstructed, but the garden hedges must be repaired, and every opening must be closed, which may be easily done by driving stakes into the earth, and nailing boards across them, which will prevent any sudden irruption of the cavalry, from which alone any danger is to be apprehended on occasions of this sort; for the infantry would scarcely advance, except by surprise, before the garrison could occupy its station. If any apprehensions are formed of an attack, the soldiers must not be absent from their post, either in the dusk of the evening, or at night; they must, on the contrary, be assembled in the intrenchments during that period, to be ready in the neighbouring houses, always clothed and accoutred.

31 Method of fortifying a church and church-yard. Fig. 2. & 3

A church and church-yard afford an admirable post of defence, especially if, as usually happens, they are seated on an elevation. In fortifying such a post, we should first block up every road and bye way leading to it, by means of waggons or carts, with their wheels taken off and loaded with dung or earth; trees laid across, or chevaux de frize. The narrow paths may be barricadoed with rails, with their points standing upwards, and a little outwards, having behind them thick branches of trees, or logs of wood, with a ditch in front. These previous precautions being taken, the doors of the church should be pierced in several places, about eight feet from the bottom, with holes large enough to admit the muzzle of the musquet, and platforms should be raised with steps within for the men to fire from. Other loop holes should be made at the bottom of the doors just above the level of the ground, and a ditch must be dug within, about three feet deep, so as to admit of men firing from thence through these lower loop-holes. See fig. 2. The doors must also be secured by barricadoes, consisting of pallisades driven several feet into the ground, and set extremely thick, some being deeper than others, so as to leave spaces between them and the top for loop-holes. See *a*, *a*, fig. 3. This barricado is technically called *tambour*. The walls of the church must also be pierced in various places as directed for the doors, see fig. 3. and ditches must be dug within them, and scaffolding erected as before.

Again, on the outside of the church, a ditch is to be dug as close to the walls as is consistent with safety to the foundation, about 12 feet in breadth at the top, and four in depth; and from the further side of this ditch the ground should be gradually sloped towards the open country. Through the main door of the church an opening should be made about two feet above the ground, sufficiently large to admit of one man passing through without much difficulty, so that when the church-yard becomes untenable, the garrison may retreat into the church.

It must not be forgotten to secure the means of a cross fire. If the church be built in the form of a cross, cross firings may be easily procured through the proper loop-holes; but when this is not the case, loop-holes should be made through every salient angle of the building, or tambours, such as represented in fig. 3. must be formed wherever it can be conveniently done.

Men must be distributed in the upper part of the building. These men will take out the tiles or slates in different places, in order to observe the approaches of the enemy, and to fire upon him when he comes within musket-shot. The lower windows of the tower or steeple must likewise be barricadoed, and have loop-holes made in them. The pavement of the church must be taken up, and the stones or bricks be carried to the top of the building, to enable the besieged to let them drop upon the enemy, when he gets sufficiently near. In order to render the defence as practicable as possible, you must also collect some large barrels or tubs, and keep them constantly at hand filled with water, for the purpose of extinguishing any fire which might break out in the church, or be effected by the enemy's shells.

Fig. 4.

Fig. 4. shows a plan of the church and church-yard thus fortified. *a*, *a*, *a*, *a*, the wall of the church-yard; *b*, *c*, tambour work in the front of the entrances; *d*, the church; *e*, *f*, tambour work constructed opposite the doors; *g*, the sacristy or vestry.

32 Of ambuscades.

Connected with the attack and defence of posts is the subject of ambuscades, which we must now briefly consider.

Ambuscades may be formed in any place where a part may lie concealed, to surprise the enemy in passing. They are easily carried into execution in woods, hollow places, and large deserted buildings; but the placing of an ambuscade in any situation requires previous accurate information with respect to the movements of the enemy. When the commander of a party has been directed to form an ambuscade, to surprise a convoy of artillery, baggage, or provisions, or a body of recruits going to reinforce the enemy, he should first make every necessary inquiry respecting the route which the enemy is to take; the situation of the places near which he is to pass, and the post to which he is about to march. He must also inquire with seeming anxiety about the roads which lead in an opposite direction, on which he should seem more intent than on his main object. Having concerted his plan, he should set out at the head of his detachment if possible, and leaving his post on the side opposite to his true route, the better to conceal his design. If the place where he intends to plant his ambuscade be not far distant, he should come into his true route about half way, and there place half his infantry in ambush to favour his retreat. But when the country where he proposes going is distant, and the march

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march requires at least two nights, he must conduct his party by meandring from wood to wood, if there be any. He must not forget to provide necessary refreshments for the day, which must be passed in some concealed place where he may not be perceived, and must cause three rations of oats to be carried for each horse.

Proper precautions having been taken to guard any cross road or bridge that may lie near the place of ambuscade, the commanding officer should take care to be at least two hours before the enemy, and to place the ambuscade on that side, by which, if worsted, he may retire with the greatest safety.

Plate DLIII. fig. 2.

Plate DLIII. fig. 2. will illustrate the proper method of laying an ambuscade. A represents the infantry of the surprising party, which ought to be placed at least 600 paces behind B, the cavalry, so that, if pursued, they may both fall back to A, and make good their retreat to the guard at the bridge or cross road; or to another party of infantry placed in ambush half way. If the ambuscade be placed in a wood, an intelligent non-commissioned officer should be chosen to get upon a high tree C, from which he can see the march of the enemy, and give notice of the most essential circumstances. The first of these is the seeing the advanced guard; the second is the approach of the corps, and the third is the time when their front is advanced as far as the ambuscade B; for which the commanding officer should instruct the observer what signals he is to make from the top of the tree, to communicate the necessary information without speaking, which may be done by means of a small cord D, of a brown or green colour, so as to be least perceptible. Let this cord be placed as in the plan, so that no branch interrupt it, with one end in the hand of the observer, and the other in the commanding officer's hand in the ambuscade B.

As soon as the advanced guard appears, the observer must pull the cord, and the commanding officer cause the party to mount and remain in deep silence. If by a stratagem, which is practised for particular reasons, the advanced guard is immediately followed by the corps, which may be easily known by their being more numerous than ordinary, and not followed by any other corps, that the commander may not be deceived by the enemy, the cord should be drawn a second time, and a third time when their front is advanced as high as the ambuscade. At that instant the party must rush out, and furiously attack the flanks of their centre in the following manner.

If the advanced guard E is formed only of an ordinary number, they should be allowed to pass; and at the approach of the principal part or convoy F, the chief to be informed by the second pulling of the cord. At the moment the head of the convoy shall be advanced as high as B, the cord must be pulled the third and last time; and at this signal the party must rush out without being perceived, and suddenly attack the centre on the flank, engaging only with their swords, and making such a noise as to prevent the enemy from hearing the orders of their officers. They must disarm all whom their bravery shall throw in their way, taking care not to scatter or pursue too far, unless it be certain that they are so far from their army or parties, on account of which they cannot be affected; for in either of these cases they will not fail to run at the noise, and disturb the retreat.

In all secret expeditions, great circumspection should be used, that the party be not seen or betrayed; as if they be discovered by the advanced guard before the blow be struck, the enterprise must be immediately abandoned, and the party retire. When the guide, or any one of the party deserts, and cannot be catched, a retreat must immediately be thought of, or the ambuscade must be placed somewhere else; but to prevent such a misfortune, the officers should be charged to examine frequently whether they have all their men.

An ambuscade should never be formed for cutting off the enemy's retreat, as this will drive him to despair, and make him rally and attack the party with desperate resolution. There may be an exception to this, when it is pretty certain that the whole party of the enemy may be cut off or taken prisoners, either from the smallness of their number, or from the peculiar situation of the place of ambuscade.

Several ambuscades should not be formed at once, except for the purpose of seizing foragers, in which case they should be disposed so that the sentinels may see from one to another. Then the first guard which sees the foragers, should commence the attack, and can soon be assisted by the rest of the party.

In all ambuscades, no sentries should be placed but officers or non-commissioned officers. On downs, behind mountains, or in gullies, the sentries should lie with their bellies on the ground, and their feet towards the ambuscade, the body covered with a gray or green cloak, according to the colour of the ground, with their heads a little raised and wrapped in a handkerchief of straw green-colour, or white in time of snow, so as not to be easily perceived. The numbers of sentinels cannot be determined, but they should be disposed so as to watch on all sides of the ambuscade, and stop every one who may inadvertently approach too near. The sentries should give notice of what they discover by gestures, to which all the officers should be very attentive. In countries where there are no woods, vineyards, or hedges, an ambuscade may be placed in a field of hemp or corn, or some sort of grain, provided it be high enough to cover the men, at least with the help of art. When the stalk of the corn is not high enough, some of the infantry must be set to work with spades and pickaxes, which they must have brought along with them, for the purpose of digging holes in the field deep enough to make up for the defective height of the corn.

Fig. 1.

An ambuscade often forms part of a stratagem for bringing on an action with a party of the enemy which would be superior, were it not for some advantage of this kind, as in the following case. See Plate DLIII. fig. 1. Suppose the whole party to set out from A, marching under the conduct of a trusty guide by covered ways at a distance from the enemy. Being come to the place C, which ought to be in the environs, and as high as the field of battle, the infantry should be concealed out of the road far from the sight of passengers. This must be the centre of correspondence with the army, the rendezvous of the booty, and support the retreat of all the cavalry, of which there should be as many detachments as there are attacks proposed to be made. We shall suppose six of 100 men each, and they must

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must go secretly by particular routes to their respective posts, E, D, F, G, H, I. Neither trouble nor expence should be spared to procure good guides. Each detachment should lie in ambush half a league, if necessary, from the object of the attack BKKKK.

The noise of the musketry in the armies is to be the signal for their irruption; and then bravery, intrepidity, and courage will give wings to the people. The second detachment D will glance imperceptibly between the villages, and fall like thunder on the camp B; and while 80 attack all whom they meet, the other 20 should light their torches at the fires that are to be found everywhere, and spread the flames rapidly to the straw of the tents. As they cannot fail to have the picquet of the camp soon at their heels, they must strike their blow with all possible expedition, without stopping to plunder, being content with the glory of having excited a general alarm, capable of confounding the whole army, and contributing to the gaining of a battle.

At the same time that the detachment D attacks the camp B, the others, E, F, G, H, must with equal violence attack the villages K, K, K, K, which they have in front, doing the same the first did in camp, except that they may seize as plunder every thing which they can conveniently carry off, with which these villages are commonly filled, seizing the best horses, hamstringing others with the stroke of a sword, and setting fire to all the places which contain the enemy's baggage. Each detachment should cause some horsemen to advance beyond the village, to observe the motion of the troops, who will not fail to run to their assistance. As soon as they perceive them, they must make their retreat as fast as possible by the routes which the commanding officer has preconcerted, and which are represented in the plate by the coarse lines. The sixth detachment I, in ambush on the side of the road leading from the camp, should remain there, to seize all the enemy who think of saving themselves by flight.

33 Of retreats.

When the commander of a detachment finds himself obliged to abandon a post, or that it is not worth defending, it becomes necessary for him to prepare for his retreat. This is often a difficult and dangerous affair, and requires much prudence as well as bravery on the part both of officers and men. If possible, he should retreat on that side which forms a communication with the general basis or line of posts occupied by his party. The following observations on lines of retreat, connected with the lines of operation described in N° 22, will be found of importauce.

Plate DXLVI. fig. 8.

A retreat on a single line is a fault of the utmost magnitude, for it is evident that if the army C (fig. 8. Plate DXLVI.) retire from it towards B, along the line AB, the enemy may send besides, two corps *a*, *d*, against the flanks of this army, which would separate it at the point B, and in this case it would be surrounded. Nor is this the only disadvantage, for all the country situated to the right and left of the line AB, would fall into the hands of the enemy; while, in a retreat, it is always a rule to cover as much of the country as possible.

Fig. 9. Fig. 10.

A concentric retreat is of such a nature, that in an extensive position they fall back to one more confined, so that the two lines of operation at the extremities AB, (fig. 9.) unite at the object of retreat C, forming an acute angle, or as at fig. 10. an obtuse angle; such a retreat would have no better issue than the former. The same disadvantages which result from retreats on a single line would likewise attend this. There is one circumstance which might induce a general to retreat in this manner, and that is, with the view of covering any important place, a capital, for example, by taking an advantageous position, which is indicated by C, in the figures; the important place required to be covered would probably be at D. But nevertheless this measure would be ineffectual if the enemy were at all versant in the art of war, and operated on the flanks of the army they were pursuing. The best method of covering a country, which is in our rear, is to proceed against the flanks of the enemy which is advancing; and by this intrepid and bold movement, to change our defensive operations into those of an attack.

Fig. 11.

A retreat conducted in parallel lines, as the basis AB, in four corps, 1, 2, 3, 4, or the lines AC, EG, FH, BD, is doubtless better than the concentric retreats which we have just considered. In the first place, the country is better covered by means of the parallel lines; secondly, the enemy cannot so easily insult the flanks of the retreating army, provided that this is in a condition to perform the same manœuvre with regard to them, and thus obstruct their progress; lastly, they would be afraid of advancing with too much precipitation, from the moment their attention is divided by the attempt which may be made against them. But there might be something still better attending it, viz. to retire in an eccentric direction, as we shall show presently.

The excellence of parallel retreats is maintained from the idea that they cover a country better, and likewise stop the progress of an enemy, when opposed in a direct line. Certainly this appears evident to the eye; but the sight is often the medium only of error. It is the *ignis fatuus* which leads us into the mire, and the present instance is a proof of it. This opinion was not indeed well founded among our predecessors, and still less is it so among the moderns. We do not now arrest the progress of the enemy, by presenting ourselves to their strongest part, viz. their front; but, on the contrary, by intercepting their flanks, which are the weakest parts; by harassing their rear; by menacing their provisions and their communication with the sources of their vigour and power. It follows from hence, that eccentric retreats are the best. An army (fig. 12.) who retires from *a*, *b*, *c*, *d*, *e*, towards *f*, *g*, *h*, *i*, *k*, runs no risk of seeing the enemy advance in the segment *f*, *k*; for he would, by such a movement, be in danger of being surrounded.

We may lay it down as a rule, that it is essentially necessary, in all retreats, to divide into different columns, in order to divert the attention of the enemy; and it is fully demonstrated that there is not in war a more important maxim. We might show that this method of attracting the attention of the enemy to many different points at once is, properly speaking, exciting a degree of apprehension with regard to his flanks and rear. But it naturally results from all that has been said relative to the inutility of diverging offensive operations, as well as those which are directed by a single line, or by an acute angle, that eccentric retreats are of all others the most preferable. Since concentric operations are the most advantageous in attacking, eccentric ones must necessarily possess the same advantages in defence; every thing

thing should be in opposition, in two different kinds of warfare, which are in their nature and interests contradictory.

In conducting a retreat, as in all other field operations, an army should assume, as the principal object, its own magazines, and the safety of its lines of convoy, rather than the army of the enemy; and it should never take a position opposite the enemy, but rather on one side of him.

34
Of battles.

We have hitherto considered military operations in the field, as they are subservient, or preparatory to, that most important consequence of war, a *battle*. We must now examine what are the causes which should induce a general to hazard or avoid a battle; and if he determine on a general action, what are the best methods of disposing the troops under his command.

At present, actions in the field are distinguished into two kinds, according as they are more or less general. When the whole of the adverse armies are engaged, it is called a *battle;* but where only a part of each is concerned, a *combat*. The latter of these, however desperate, does not in general involve such important consequences as the former; but as in a general engagement, the vanquished party usually lose the greater part of their artillery and baggage, and are compelled to retire and leave the country behind them at the mercy of the victors, a prudent general never hazards such losses without important reasons.

35
Reasons for hazarding a battle.

When an army is superior to its opponents in number or discipline; when discord prevails among the chiefs of the adverse army; when a neglect of the ordinary precautions in marching, encamping, or other obvious duties, demonstrate their incapacity; when it is necessary to relieve a considerable town or post that is besieged by the enemy; when it is apprehended that the army will be dispersed or ruined, without a general engagement; when intelligence has been received that reinforcements are approaching to the enemy, which will render him superior; when the enemy has received, in some preceding action, a considerable check which he has not yet recovered, or when the army whose general is thus canvassing the advantages and disadvantages of a battle, is in such a state, that every thing ought to be hazarded for its relief, the commander is warranted in giving battle to the enemy.

36
Reasons for avoiding a general action.

On the contrary, when less is to be hoped for from a victory than feared from a defeat; when the army is inferior either in number, courage, or discipline, to the enemy; when it is in expectation of being reinforced by a strong detachment of fresh troops; when the enemy is so advantageously posted that it would be impossible to bring him to an engagement on equal terms, or to force his entrenchments; or when there is a prospect, by temporising and declining battle, of ruining the army of the enemy by disease, famine, or desertion, it would be wrong to place the fortune of the campaign on the issue of a battle.

37
Preparation for a battle.

When a general engagement has been resolved on, the general is to devise the means of carrying it into execution, so as to have the strongest presumption of success. He is to arrange, with the officers of his staff, the manner in which the troops are to be divided and disposed, or what is called the order of battle; he should assign to his several officers their respective posts, and see that copies of the order of battle be given to those that have a separate command. The proper officers should take care that the troops under their command be properly armed and equipped, and that they are allowed time to rest and refresh themselves before the engagement. The heavy baggage, and every thing that might encumber the operations of the troops, should be removed, and placed at a distance under a proper guard. A reserve should be formed near the park of artillery, consisting of some of the bravest and best disciplined troops, headed by the most experienced officers.

38
Circumstances to be attended to during the action.

In time of action, the commander in chief should be so situated as to be able to issue his orders with the least difficulty, and to observe as far as possible the operations of his troops, and more especially the effects of the first attack. Every other general officer must keep his own station, to direct the charge of the troops, or to rally and re-form those which have been routed and dispersed. When the action becomes general, and is obstinately contested, the commander-in-chief should direct the principal efforts of his troops against that part of the enemy's line which makes the greatest resistance, and should himself hasten to this spot, to animate his men to greater activity and exertion by his presence and exhortations.

The artillery of the army should accompany the first line, and the remainder of the troops should follow the movements of those before them, so as to preserve the proper distance between the lines, and march with the least possible disorder and confusion. If the first line give way, the second should march up to its relief, and either charge the enemy, or keep him employed till the first line has time to rally and re-form. If, however, as often happens, the other lines are struck with a panic on observing the repulse of their predecessors, the reserve should be brought up, and it is probable that their courage and resolution will reanimate the scattered troops, and turn the fortune of the day.

39
Order of battle.

In forming the order of battle, regard must be paid to the nature and situation of the place where the battle is to be fought; to the number and quality of the troops engaged, and to the mode of fighting which is most likely to take place during the action, or to decide the victory. There are two principal methods of forming troops in order of battle, the column and the line. The former of these was most in use among the ancients, has been greatly recommended by Folard in his commentaries on Polybius, and practised with the most brilliant success by the French armies since their portentous revolution. This order of battle is adapted chiefly to cases where the activity of the troops can be relied on, and where much firing with musketry or artillery, is not expected to take place, and where of course the affair is to be decided principally by the pike or the bayonet. It is also well calculated for a body of infantry who are to resist the attack of cavalry. It is obvious that from the close arrangement of troops in column, this disposition must expose them more to the fire of a line, and must endanger their being flanked or surrounded by an enemy whose front is more extended. The relative advantages and disadvantages of the column and the line, will be more readily perceived by attending to the following principles.

From the order of battle as a basis are deduced many instructive

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instructive principles relating to what are called *lines of marching* and *lines of firing*, which constitute a considerable part of the elements of modern tactics.

40
Principles of marching and firing, deduced from the order of battle.

There are as many lines of marching arising from the order of battle, as there are soldiers in the first rank of the line or column, and as the soldiers approach towards the enemy, these lines of marching, at least in the infantry, produce lines of firing. It is the nature and relative advantages of different lines of marching and firing that we now propose to consider.

Plate DXLVI. fig. 13.

Let us suppose two lines of troops, A and B, fig. 13. extended opposite to each other, of which A is considerably longer than B at each extremity, or, as it is termed, outflanks it. It is evident that B may be surrounded by A, as from the superior numbers of A, B may be attacked in flank and rear. It is therefore evident that when the numbers are unequal, and the contest is to be decided by firing, the greater number must prevail, if both are arranged in lines.

Fig. 14.

Again, the line AB (fig. 14.) being attacked by the line *c d*, the flank B cannot extend itself parallel to *c d*, if this line advances always in front towards A. The line attacked is surrounded, and even so pressed upon, that they must all take flight towards A. If any troops by chance should endeavour to form upon the line *e f*, they would not have time; taken in front and in flank by the enemy's fire, they could never resist such an attack. The cavalry would experience the same disadvantages in a similar case. Horsemen attacked to the right, to the left, and in front, could not defend themselves; the celerity of the horses, no doubt, would enable them to deploy quicker than the infantry; but, by the same reasoning, the enemy's cavalry, which is advanced upon their flank, would likewise advance the quicker from the point B, towards the opposite wing A, which a corps of infantry could not possibly do. Thus it would be equally difficult to form the line *e f*; every thing would be overthrown, and they must retire in the greatest disorder towards A. It is hence clear that every effort should be made by an army in line of battle, to turn the enemy's flanks with its front.

Concentric lines of marching and firing well executed, are exceedingly important. Hence it is that a fortress must yield when it is besieged, as the fire from the fortress is *eccentric*, while that of the besiegers is *concentric*. Hence, too, sorties from a garrison rarely succeed, because they are eccentric operations.

When an army is much weaker than its opponent, if the former be compelled to an action, it should throw itself on the enemies flanks; and to do this with effect, the enemy's front should be kept occupied, so as to draw off his attention from his flanks. If the line were long, he would have time to convey all that part opposite to the side attacked, as A (fig. 15.) into the line *e f*, before the attacking army *e d* could entirely overthrow and repulse the flank B, which would be the object of their efforts. In this case, things would again be equal; for an engagement in front would take place, the issue of which is always doubtful. If, however, they occupy the line AB, by corps sent for that purpose, as *g* and *h*, while, with a greater force, they attack in flank, then it would be impossible for any part of AB to throw themselves into the line *e f*, before having beaten *g h*; and the time would probably be too short for this operation, if *c d* pushed in front in a vigorous manner. From this it follows that the army AB, though the stronger, can do nothing better at this time than quit the field of battle, as it will otherwise be surrounded. Now, the attacking army have nothing to do but to effect an eccentric retreat; namely, to fall back with the left wing upon *i k*, and with the right upon *l m*, provided CD do not obstruct the passage; for in that case, the retreat of the right wing, or of that part of the army nearest the flank B, would be on *n*, in order to create in the enemy *c a* some solicitude for his left flank *d*. It is by such eccentric retreats that the pursuit of the enemy is prevented. They dare not venture it, if they do not wish to be taken in flank themselves, and to become in their turn exposed to an escalade and a concentric fire, and consequently a terrible havoc. Eccentric retreats in tactics are equally as advantageous as in strategy. The latter kind alarm the enemy with regard to his lines of operation, and consequently prevent him from advancing; the former make him afraid of exposing his flanks and rear, and hinder him from pursuing.

Fig. 15.

From these considerations it appears that it is no great misfortune for an army to be attacked in its centre, and divided. If the army be divided in two at the centre, it will retire eccentrically on *e* and *f* (fig. 16.). By this movement it will throw an obstacle in the way of all farther progress on the part of the enemy, who has divided in the middle the dotted line AB. It is impossible for the enemy *c d* to advance in front between *e* and *f*; they would take him in flank on both sides; he must therefore advance in front towards *e* and *f*, both at the same time. In this position *e* and *f* might detach forces to the rear of *c d*, and operate at once on its provisions and in its country. It would be sufficient for that to send some corps from their flanks to the points A, B. It is likewise possible for them to advance entirely to the left and right, if they have any magazines at *g* and *h*, which nevertheless would not be exposed by the marching of the flanks towards A and B, and would always be sheltered from the enterprises of *c d*. A third combination likewise would be to attack immediately *c d*, which, from its position, would be exposed on both its flanks. In this last case, *c d* would have no other resource than to operate on that part of the flanks *e* and *f*, which are opposite to the points A, B, to compel *e f* to retreat, and replace its front in the direction of A, B. Fig. 16.

It does not require a great body of men to occupy the front of the enemy, while the rest of the army attack the flanks. It is best done by means of a scattered troop, or what the French call *tirailleurs*, consisting of light infantry, which are usually instructed in the following manner. The troop, formed into two ranks, divides in such a manner that there may be a space between the two, as indicated in fig. 17. The second rank, placed behind the intervals left by the first, secures its flanks. When they attack, the second rank, CD, passing through the intervals of the first AB, advances to the line EF, and fires. The great advantage arising from this, is that of forming a more extensive front than when they are wedged in elbow to elbow; secondly, they keep up a more fatal fire with their musketry, because each soldier, being unmolested by the one next to him, aims better, and continues his firing without interruption; thirdly, a less number of men is lost, because Fig. 17.

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bayonets, it would be sufficient for a division of the line AB to make a conversion on the flank of the *échellon* *c d*, while they are fighting in front, and overthrow it before *e f*, 300 paces distant, or even the second line of the *échellon*, could come up to afford it any assistance. Thus, according to all appearances, the line AB would conquer all the *échellons* successively, and this the more easily as they would be taken in flank as soon as *c d* is obliged to fly.

The most useful, and in fact the only process for reinforcing an attack, is to have a second line of cavalry behind a first of infantry; in case of bad success they secure and cover their retreat, and complete the disorder of the enemy's infantry, if they come to an engagement.

When the infantry is ranged *en echiquier*, a first line when beaten, may retreat by files through the lines in the rear, without creating any disorder in the second, on account of the extensive spaces; but it is not the same with the long phalanx in open order. The cavalry, placed immediately behind the infantry, protects an attack much better than if there were between them a second line of infantry; for in the first instance, there would be no hindrance to their hastening to the succour of the runaways, and receiving them in their bosom. Hence there should be only two lines, one of infantry, and one of cavalry; and this is the more important, because the two lines of infantry cannot be useful, except in as far as they are beyond the shot of the cannon; it is evident, therefore, that they should be considered rather as a reserve of fresh troops than as a second line of combatants. Hence, the superadded strength which is supposed to be given to the *échellons*, by double lines of infantry, is quite illusory.

Cannons which fire concentrically, assist greatly the efficacy of an attack; but this measure may be employed as well for right lines as for the *échellons*: in an attack of the latter kind, the batteries should not be placed before the division *c d*, but before *e f*, to enfilade that part of the line AB, which would attempt to fall back to make a conversion, in case it were attacked in flank by *c d*.

It is impossible to take the enemy in flank by the diagonal or side-step, executed during the march, if, previous to commencing their march, they are not already considerably by their wings; for they would completely frustrate that scheme, if they made directly with their flanks a movement to the side. During the same time they would pass over a more considerable extent of ground than with an oblique step, because they move in a direct line, and in front, and obliquely, both at the same time, which would considerably shorten their distance; and likewise because they march on one of the sides and you on the hypothenuse, which is longer. It is therefore impossible to succeed in stretching beyond the wings of the enemy, while they are advancing in front in the order of battle, if they know how to conduct themselves.

There is, however, one advantage to be noticed, which the *échellons* possess over the uninterrupted oblique front, which is, not exposing the flank to the enemy advancing in front. The *échellons* naturally possess this advantage, while the oblique front cannot obtain it without being much more extensive than the enemy's front; for the oblique line, formed into *échellons*, changes into a number of parallel lines by a conversion (fig. 38.), and they may, by this movement, defend their flanks against the enemy. But still the best way is to attack him in his own flanks, whilst his front is amused with detached corps, and the columns should be prepared for the principal attack out of sight of the enemy, in the same manner as an admiral adopts at a considerable distance, his measures for gaining the windward of the enemy. No manœuvres within cannon-shot can possibly be attended with success, if the enemy be skilful.

Fig. 38.

41 List of remarkable battles.

Much useful military instruction may be derived from perusing the accounts of the most celebrated battles, detailed by writers of ancient and modern history; and we could here enumerate a long list of these engagements, many of which have been described in the historical articles of this work. A few, however, must suffice. Of ancient battles we may notice those of MARATHON * in 490 B. C.; Platæa, 479; LEUCTRA *, 371; the GRANICUS *, 334; ARBELA *, 331; the Thrasymene Lake †, 217; CANNÆ *, 216; ZAMA *, 202; Magnesia ‡, 190; Nepheris, 147; PHARSALIA *, 48; and PHILIPPI *, 42. Of modern battles, the most important are those of HASTINGS *, A. D. 1066; the Indus ||, 1221; Bannockburn §, 1314; CRESSY *, 1346; POICTIERS *, 1356; AGINCOURT *, 1415; Bosworth **, 1485; Flodden §, 1513; Pavia, 1525; Narva ††, 1700; BLENHEIM *, 1704; RAMILLIES *, 1706; Pultava ††, 1709; MALPLAQUET *, 1709; Fontenoy ‡‡, 1745; Prague and Colin ||||, 1757; Lissa or Leuthen ||||, 1757; Minden, 1759; Freyburg, 1762; Jemappe, 1792; Tirlemont, 1793; Fleurus, 1794; Lodi, 1796; Zurich, 1799; Ulm, 1800; Marengo, 1800; Austerlitz, 1805; and Wagram, in 1809.

* See these articles. † See Carthage, N° 115. ‡ See Syria, N° 48. || See Grana. § See Scotland, N° 192. and 405. ** See England, N° 257. †† See Russia, N° 109. and 115. ‡‡ See Britain, N° 414. |||| See Prussia, N° 26, 35.

By way of illustrating the modern French tactics, and more fully explaining what has been said on the order of battle, we shall here give a detail of the battle of Jemappes, in which Dumourier entirely defeated General Clairfayt, by enticing him from a situation where he was impregnable.

42 Battle of Jemappes. Plate DLIV.

In the beginning of November 1792, when Dumourier arrived with his army in the vicinity of Mons, he found the Austrian general Clairfayt occupying a strong position on the heights near the village of Jemappes, where he had entrenched himself, and was defended by nearly 100 pieces of cannon. The position of the Austrians was extremely formidable. Their right extended to the village of Jemappes, and formed a square with their front and left, which stretched to the causeway of Valenciennes. They were posted on a woody mountain, where they had erected, in an amphitheatre, three tiers of redoubts. Their whole force amounted to about 16,000 infantry, and 3000 cavalry.

The army of Dumourier was much more numerous than that of Clairfayt, but not so well supplied with artillery. The elevation of the Austrian batteries, too, gave them such an advantage, that the French cannon could produce but little effect.

On the 5th of November, Dumourier had fully reconnoitred the Austrian camp, and, by way of feint, made an attack with his infantry on the village of Carrignon, while he kept up a brisk cannonade on their left. Towards evening the French army encamped opposite to Jemappes, with its left wing extending to Hoorne, and its right to Fremery. As Dumourier resolved

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solved to make a decisive attack on the height of Jemappes the next morning, he ordered his troops to abandon the village of Carrignon which was commanded by the enemy's cannon.

On the morning of the 6th, he ordered his artillery to be advanced and disposed along the front of the line. It was soon found, however, that little was to be done with artillery, and that the great object was, to entice the Austrian general from his strong position, and draw him to the plain. For this purpose, at noon of the 6th, the French infantry formed in columns, and advanced with the greatest spirit and rapidity to the Austrian intrenchments. The lower tier of redoubts was instantly carried; but, as the centre of the French became endangered, and the Austrian cavalry appeared descending from the heights, and preparing to enter the plain, with an evident intention of flanking the French columns, Dumourier despatched the duke of Orleans to lead those columns against the second tier of redoubts, while a detachment of chasseurs and hussars flew to check the progress of the Austrian cavalry. Some smart skirmishing between the cavalry on both sides now ensued, and while this diversion was taking place, the left division of the French army possessed themselves of the village of Jemappes, while its centre obtained entire possession of the second tier of redoubts. In the mean time the whole of the Austrian cavalry had quitted the heights, and engaged the French on the plain below Jemappes. This was the point to which Dumourier had wished to bring them, and now the superior numbers and activity of the French quickly decided the fortune of the day. The Austrians were routed at every point, and forced to abandon the field of battle, leaving 5000 of their dead, with the greater part of their artillery. The loss of the French, however, was considerably greater, and is, on good authority, estimated at 14,000; but this loss appeared trifling to Dumourier, as by this victory he acquired possession of the whole of the Austrian Netherlands.

The positions of the French and Austrian forces in this battle are represented in Plate DLIV. 1, The centre of the Austrian army, commanded by Clairfayt. 2, A part of this army commanded by General Lilien. 3, Another part under the command of General Beaulieu. 4, Redoubts on the heights of Jemappes. 5, Austrian intrenchments. 6, French columns advancing to attack the intrenchments. 7, A battery. 8, Columns of cavalry. 9, Columns attacking the eminences above Mons. 10, Battery on the height of Fremery. 11, The wood of Fresnee. 12, The plain on which the French and Austrian cavalry were engaged. 13, Austrian detachment.

The columns N° 9. were first engaged; and N° 6. having obtained some advantage, Dumourier ordered the battery, N° 7. to be erected, by which the redoubts, N° 4. were silenced. In the mean time the French advanced against the intrenchments, 5, and attacked in front. From the left of the French army, as far as the centre, the cavalry fought hand to band, in the plain, 12, with the Austrian horse, which was dreadfully cut up in the wood of Du Fresnee, 11. The right of the Austrians, being totally routed, gave way and fell back on Mons. The superiority of the French in numbers is evident from inspecting the columns in the plan.

After having dwelt so long on that part of military tactics which relates to operations in the field, we must be extremely brief with respect to the attack and defence of fortified towns. Indeed our principal object in this part will be to explain the nature of a siege, and the various circumstances that may occur, both on the part of the besiegers, and on that of the besieged, rather than to lay down a system of instructions for either party. With this view, we shall first enumerate the principal instruments and engines employed in the attack or defence of a fortress, and explain the nature and construction of the works constructed by the besiegers, either for the purpose of making their approaches to the place, or for undermining its walls or outworks.

43 Of sieges.

44 Instruments employed in sieges. Plate DLV. Fig. 1—20.

In Plate DLV. are represented the principal instruments employed in sieges. Fig. 1. is a fascine for the construction of redoubts or temporary defence of a detachment. Figs. 2. 3. and 4. exhibit various views of what are called *gabions*, or cylindrical cases of wicker work, open at both ends, for sticking into the ground, as seen at fig. 4. when they are filled with earth, and fascines, &c. laid on them. Fig. 2. is a section of the gabion; fig. 3. shews its hollow inside, and fig. 4. is its elevation. Fig. 5. and 6. represent bags for holding sand, the former empty, the latter full; and fig. 7. represents the manner in which they are usually disposed for the protection of the men. Fig. 8. is a saucisson, or very long close faggot, for laying over gabions. Fig. 9. is the outline of a blind, which is stuck into the earth by the sharp stakes at its extremity, and hides the workmen from the besieged. Fig. 10. represents what is called a chandelier, and fig. 11. two of these with fascines piled up across them. Fig. 12. is a cheval de frize; fig. 13. 14. 15. exhibit various views of a *mantlet*, or moveable blind placed on two wheels, used both to protect and conceal the workmen of the besiegers. Fig. 13. is a plan of the mantlet; fig. 14. a side view of it, and fig. 15. a view of its front next the enemy. Fig. 16. is a madrier or screen with two leaves, moveable on wheels; and fig. 17. represents a gate with orgues or lattice work on one side, and a portcullis on the other. Fig. 18. is a hook, and fig. 19. a fork used in sapping. Fig. 20 represents three caltrops or crows feet, used to scatter over the ground, to prevent the approach of cavalry, by laming their horses feet. For a fuller explanation of these instruments, see the several articles in the general alphabet.

45 Of investing.

When a town is about to be besieged, it is first *invested;* that is, a considerable body of troops, usually cavalry, encamp in its neighbourhood, and take possession of all the avenues till the army arrive, which is to carry on the regular operations of the siege.

46 Of lines of circumvallation.

When the army has *sat down* before the place, its first object is, to ascertain the lines or direction of the works to be thrown up for the attack of the place. These are called *lines of circumvallation*, and their direction is to be determined by the plan of the fortification about to be besieged. After ascertaining, in the manner explained under Fortification, the number of sides of which the polygon of the place consists, and the length of each, as well as the radius of a circle to be drawn round the place, concentric with its works, the polygon of the circumvallation is easily described. This being traced, the engineer takes on each of the extremities of its sides the lines BD and BE, fig. 21. each of 15 fathoms, and from the points D and E, Fig. 21.

taken

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taken for the centre and distance of 25 fathoms, he describes two arcs cutting each other at F, whence are drawn the lines FD, FE, for the faces of the redans of the line of circumvallation; thus are formed the salient parts EFD of this line, which serve to flank it. The same operation is performed on every side of the circumvallation, and then the principal line is traced. The parapet within must be six or eight feet deep, and without is made a ditch parallel to all its parts, three or four fathoms in breadth. The parapet of the circumvallation will be $7\frac{1}{2}$ feet high, and the depth of the ditch equal to the height of the parapet.

Fig. 22. To make the profile of the circumvallation, let AB, fig. 22. be a line level with the country, and CD the scale of the profile. Let A be the side of the town, and B that of the country; take AE of six feet; from the point E, raise the perpendicular EF, of three feet, and draw the line AF, which will be the talus or slope of the banquette.

Draw FG parallel to AB, three feet from F to G, and the line FG will be the breadth of the banquette. On the point G raise the perpendicular GH, on the line FG, $4\frac{1}{2}$ feet. Draw from the point H, HK parallel to AB; make HK $7\frac{1}{2}$ feet, HI, $1\frac{1}{2}$ foot; draw GI, which will be the inside of the parapet of circumvallation.

From the point K, let fall on the line AB the perpendicular KM; take KL $1\frac{1}{2}$ foot, and draw IL, which will be the upper part of the parapet of the line of circumvallation. Take MN equal to five feet, and from the point N draw the perpendicular NO, and set off $7\frac{1}{2}$ feet from N to O. Draw OR parallel to AB, making the distance equal to 18 feet from O to R; draw LN, and produce it to P, and LP will be the scarp. From the point R raise RS, perpendicular to OR, or parallel to ON. Make QR=OP, and draw QS, which produce beyond S, three feet to V; then take SX equal to six feet, and draw VX, and the profile of the circumvallation is completed; VQ being the counterscarp, and VX the glacis.

At A and A (fig. 21.) are small half moons before the gates of the circumvallation in the middle of the curtains.

Plate DLVI. fig. 1. -- 3. In Plate DLVI. at fig. 1. is represented the manner in which the lines of circumvallation were drawn at the siege of Philipsburg in 1734. In these lines regular bastions were constructed, as seen in fig. 2.

Fig. 4. 5. Fig. 4. and 5. of the same plate represent another line of circumvallation drawn round the city of Arras, when it was besieged by the Spaniards in 1654. Before the circumvallation were dug a great number of holes, two feet in diameter, and $1\frac{1}{2}$ foot deep, in which were fastened stakes for obstructing the approach of cavalry.

47 Of the trenches and parallels.

While the lines of circumvallation, which are intended to protect the besiegers from the enemy without, are constructed, all materials necessary for the trenches are got ready, and the figure and direction of these are determined. If the place be regularly fortified, and stand on level ground, it is indifferent on which side the besiegers commence their attack. Suppose C, fig. 2. Plate DLVII. to be the place besieged, and A and B two bastions to be attacked. The besiegers begin with indefinitely producing towards the field the capitals of these two bastions; in like manner the capital of the half moon opposite the curtain between these two bastions is produced. Eight hundred fathoms are set off from the salient angles D and E of the covert-way of F and G. This done, the lines DH and DI are drawn, each equal to 300 fathoms, and about the centre C with the radius CH or CI, is described an arch produced beyond H and I, and on this arch HI is constructed the first parallel. Then on the same lines DF, EG, are taken the points M and N, each 140 fathoms distant from H and I; and through these points M and N, about the centre C, is described another arch, on which is constructed the second parallel. This second arch will cut the produced capital of the half-moon in the point L, which is to be observed, in order to begin from hence a trench which may extend to the salient angle of the covert-way before this half-moon. Lastly, through the points O and P, the distance of 20 or 25 fathoms from the angles D and E, a third arch is described from the centre C, on which the third parallel is constructed. The first parallel is terminated by producing the faces *a b*, *a b*, of the half-moons 1 and 2, collateral to the bastions A and B; but the parallel is extended 15 or 20 fathoms beyond the intersection of this prolongation. The second parallel will be less extended than the first, by about 30 fathoms on each side, and the third less than the second by the same distance.

Plate DLVII. fig. 2.

The trenches or approaches are now to be traced. For this purpose, the engineer takes a long ruler, and lays it on the point G, so that it may make with the produced capital EG of the bastion B, an angle EGS, whose side GS being produced, shall meet no part of the covert-way, and shall be distant about 10 or 12 fathoms from the angles to which it approaches nearest. GS is taken of any extent, and the ruler is put on the point S; so that it shall make with GS such an angle GST, as that the side ST produced shall not fall on any part of the covert-way, but be 10 or 12 fathoms distant from the most salient parts. This side is terminated in T; and now the angle STI is made, whose side TI should terminate at the point I, where it meets the first parallel. The same operation being performed on FH, the outline of the trenches is completed as far as the first parallel.

Fig. 1. of this plate illustrates the method of constructing what are called *lines of countervallation*. These are drawn nearer the town than the lines of circumvallation, but are constructed on the same principles. They are employed chiefly when the garrison of the place is so strong as to disturb the operations of the besieging army by sallies.

In sieges where the garrison is strong, it is often necessary to cut parts of trenches, as VV (fig. 2.) between the second and third parallels, so as to communicate with the main trench. These parts of parallels are denominated *half parallels*, or places of arms, and are constructed in the following manner. Let ABCDFGMQ (fig. 1. Plate DLVIII.) be a part of the trenches, and let AB be one of the sides opposite to the enemy; produce AB, so that BE shall be five or six fathoms, and in FG take also five or six fathoms from I to L, which will give the ends of the trench BFLI, the use of which is to cover the *boyace* or branch IOMG, whereby the enemy will not know the place where it falls into the trench AB, and to make room for withdrawing those who are in this part of the trench- Plate DLVIII. fig. 1.

es,

Military Tactics. es, and that the passage may be free at all the angles. In like manner produce the side GM from M to N, and the side IC from O to P, and this will give the end of the trench MNOP, which will cover the branch DCOQ. The same is to be done at all the angles of the trench. The parapet of the trench being made to cover it, ought to change sides alternately. If, for instance, AE, in the preceding figure, be towards the place, it is evident that the side GN will be towards it also, and likewise the side CD; and therefore the parapet of the trench is successively constructed from the right side to the left, and from the left to the right.

Figs. 2. 3. 4, of this plate represent profiles of the regular trenches and the places of arms, and require no particular explanation.

In tracing the trenches, it is of the greatest consequence to ascertain the distance of the extremity of the line of direction to the top of the salient angle of the covert-way. The following simple method of doing this is given by Vauban. Let A (fig. 5.) be the vertex of the salient angle of the covert-way, and AB the line of direction of the trench whose length is required. At the point B, draw BC perpendicular to AB, to which give any measure, and at the point C draw CD perpendicular to BC. In CD take any point E, and in the line of direction between it and the angle A place a picquet G in the line BC. Measure GC and CE, and say as GC : BG :: CE : AB.

Fig. 5

48 Of saps.

When in carrying on the trenches towards the town, the workmen begin to be much annoyed by the fire of the besieged, recourse is had to what is called *sapping*, which may be thus explained. Let ABC be the part of the trenches advanced to A (fig. 6. Plate DLVIII.), so near the town as to render it impossible, without evident danger, to work any longer at the approaches, unless the men have some cover against the fire of the place; and let the branch AD be traced by the engineer, not with a cord, as at the opening of the trenches, but with some pickets, which he has taken care to place in the direction this branch ought to have, to serve as a guide to the workmen. A cut is made in the parapet BA of the trenches, and then the men designed to work by sap, who are therefore called sappers, will move forward through the opening A successively, eight in number. Fig. 7. of Plate DLVIII. and fig. 1. of Plate DLIX. will illustrate the mode of operation. The first sapper rolls a mantlet before him, and places a gabion on the line AD, fig. 6. He then makes a small excavation about six inches from the gabion, of about one foot and a half in depth, and as much in breadth, emptying the earth which he digs up into the gabion. He then pushes forward his mantlet, fixes another gabion, and continues his trench as long as he is able. He is followed by a second, who widens the trench six inches in breadth away from the gabion, and six in depth. The rest follow this second, till the trench is made three feet wide, and as many deep, and as soon as the gabions are filled with earth, fascines or saucissons are placed on their top, and the superfluous earth is thrown over them, and on the opposite side, by way of parapet.

Plate DLVIII. fig. 6. 7. 8. Plate DLIX. fig. 1. 2.

49 Of batteries.

Cannon are made use of at a siege for two different purposes; the first to drive away the enemy from their defences, and the second to dismount their guns. To produce these two effects, the batteries should not be above the mean reach of cannon shot from the place; that is, above 300 fathoms. Therefore there is no possibility of constructing them till the first parallel be formed; and as the distance of this first parallel from the place is generally 300 fathoms, the batteries must be on this line, or beyond it, nearer the town. They must always be placed, when the ground will permit, on the produced faces of the works attacked. Let Z be the centre of the place attacked (fig. 3. Plate DLIX.), and the trenches as well as the parallels completed. To find a proper position for erecting batteries, produce the faces AD, AC, BE, BF, of the two bastions attacked, till their prolongation cuts the first parallel. Produce also the two faces OM and OL of the half-moon MOL of the front attacked, and the faces HG and IK of the two collateral half-moons 1 and 2, to the first parallel, and erect batteries on those produced faces, as is seen in P, Q, R, S, T, U, X, and Y. They are advanced beyond the first parallel 40 or 50 fathoms; and are parted from the trenches, that they may be used with greater ease and convenience, and less trouble to the workmen.

Plate DLIX. fig. 3.

50 Of traverses.

When the works of the besiegers approach the glacis, they are continued in a zig-zag direction, by short angular trenches, but from the foot of the glacis they are continued in the following manner. Two sets of sappers, protected by their mantlets, make a sap on each side of the ridge of the glacis, with a deeper ditch than usual, and a parapet on each side. This is called a double sap, and has across it traverses or banks three fathoms thick (see Plate DLX. fig. 1.), with small passages on one side (see fig. 4.) to preserve the communication. These traverses are constructed so near to each other, as to be a sufficient cover, by their elevation and distance, against the fire of the place. In order to guard against the effect of grenades, on coming within their reach, or within 14 or 15 fathoms of the covert-way, care must be taken to cover this trench with blinds, or to cover the upper part of it. Fig. 1. and 2. of Plate DLX. shew this direct trench. The first exhibits the plan, and the second the profile, which passes over one of the traverses. This being done, and the third parallel finished in the manner supposed, they advance from this parallel on the glacis to each of the salient angles of the covert-way of the front attacked, and begin with making two or three short turnings, as marked on Plate DLX. fig. 6. along the ridge of the glacis, so as to occupy about one-third of it. These are to be made as deep as is necessary, to be a shelter against the fire of the covert-way; afterwards they may proceed directly along the ridge of the glacis by a deep ditch, to the salient angle of the covert-way. M. Vauban observes, that if we follow directly the ridge of the glacis, this trench is made without much danger; for the palisade which is placed at the salient angle of the covert-way, and the other two next it, do not present directly to the ridge, but only opposite to the faces, where at most there is only room for one or two fusileers to see the head of the trenches, and who are easily silenced by the fire of the third parallel, which ought to be well served, and likewise by that of the ricochet. On coming to the middle, or two-thirds of the glacis, two new saps are made, *b b*, *ibid.* which embrace both sides of the covert-way, to which they are almost parallel. Their length is 18 or 20 fathoms, and about five broad.

Plate DLX. fig. 1.

Fig. 6.

Military Tactics. broad. They are covered at the end with crochets and winding traverses, which prevent the fire of the covert-way from enfilading them easily.

Fig. 5. Plate DLXI. fig. 5. In this way is gradually effected a *lodgement* on the covert-way, as is represented in fig. 5. where AAAA, is the trench, with BBBB its traverses.

Plate DLXI. fig. 5. represents a profile of these works, with three banquettes next the trench, by which the parapet is raised, so that the soldiers may fire over into the covert-way. This work is called by Vauban, the *cavalier of the trench*.

51 Of batteries on the covert-way.

When the besieged are entirely driven out of the covert-way, the next thing to be done is the erecting of batteries, in order to ruin the defences of the place, and to make a breach. As it is necessary for the besiegers to make themselves masters of the half-moon C, (Plate DLX. fig. 6.) before they can come to the body of the place, which is defended by part of the faces of the bastions A and B opposite to its ditch, they must begin with erecting batteries on the covert-way opposite to these parts. They are marked on the plan *e e*. Batteries must also be erected to make a breach on the half-moon. But, before they are erected, it will be proper to consider what part of the face of the half-moon is to be attacked, or what part of the half-moon is to be entered. It must not be at its flanked angle, because an opening towards the point would not afford a sufficient space to make a lodgement able to withstand the enemy, and the troops would be seen in their passage by the two faces of the bastions by which its flanked angle is defended. The most favourable passage is towards the third part of its face, reckoning from its flanked angle, because by battering at the same time the two faces near this part, the whole point of the half-moon may be destroyed, and a large opening made there easier than anywhere else. Thus the batteries for making a breach in the half-moon C will be placed in *d* and *b*, and will occupy almost one-third of each of the faces of the half-moon from its flanked angle. These batteries are each to consist of four or five pieces of cannon. When the faces of the bastions A and B are well enfiladed by ricochet batteries, there will be no farther occasion for the batteries *e*, *e*, and when the half-moon is taken, the faces of the bastions A and B may be destroyed, by using the batteries *d*, *d*, placing them in the situation of *e*, *e*. Batteries must also be erected to destroy the flanks of the demibastions in the front of the attack; and it is evident that they can be placed nowhere but at *i*, *i*, on the covert-way. Besides these batteries, others are erected in the re-entering places of arms of the covert-way, as in *k*; and in *k* they serve to batter the tenaille when there is one, the curtain, and the faces of the bastions. Sometimes they are of mortars for throwing stones.

52 Descent and passage over the ditch of the half-moon.

While the workmen are employed in erecting batteries on the covert-way, preparations are made for passing the ditch of the half-moon. This is often a difficult and dangerous undertaking, as this ditch is commonly very deep, is well defended, and either filled with water, or in general capable of being so filled. The descent into the ditch is commonly effected by subterraneous passages or galleries, made like those of miners, and erected in such a manner, that its opening into the ditch may be opposite to the breach where it is intended to make the assault. These galleries are sloping, and in general there are several for the same passage. The passage is made on each side of the faces of the half moon. See *m m*, fig. 6. Plate DLXI.

As the business of forming these galleries is liable to be obstructed by mines from the besieged, the workmen are protected by a guard of grenadiers. At fig. 1. Plate DLXI. is seen a plan of the descent under ground, and of its opening into the dry ditch; and fig. 2. gives a profile of the same passage; fig. 3. gives a perspective view of the opening of this descent, seen from the bottom of the glacis, and fig. 4. a similar view of the opening of the same descent, seen from the top of the breach.

Plate DLXI. fig. 1—4.

At Plate DLXII. fig. 1. is seen the plan of the passage over a wet ditch in the open air; that is to say, the gallery of which is an open sap. A is the opening of it; at B, towards its opening, are seen the blinds laid on its upper part, to support the fascines with which it is covered. On these blinds, at first, is laid a bed of fascines, ranged according to the length of the gallery: over this first bed a second is laid, whereon the fascines are ranged according to the breadth of the gallery, as is seen at B and C. D is the epaulement of fascines, which covers the passage against the fire of the place by which it is flanked. E is part of the bridge of fascines; and F is an elevation also of fascines, intended to cover the head of the work, and to secure it from the immediate fire of the place. Fig. 2. represents the profile of this descent into the ditch. Fig. 3. gives its opening seen in perspective from the country; and fig. 4. its opening into the ditch, also in perspective, as it appears from the top of the breach.

Plate DLXII. fig. 1—5.

The following references will explain fig. 5. of Plate DLXII. *a*, cavaliers of the trenches. *b*, batteries of stone mortars. *c*, batteries to breach the half-moon before the hornwork. *d*, batteries against the defence of this half-moon. *e*, passages over the ditch before this half-moon. *f*, lodgement in it. *g*, batteries against the flanks of the hornwork. *h*, batteries to breach the half bastions of the hornwork. *i*, batteries against its curtain. *l*, lodgements in the half bastions, and in the hornwork. *m*, passages over the ditch before the retrenchments in the hornwork. *n*, lodgements in these retrenchments. *o*, batteries against the defences of the collateral half-moon. *p*, batteries to breach those half-moons. *q*, passages over the ditch before these works. *r*, lodgements in the same. *s*, batteries to breach the redoubts of the half-moon. *t*, passages over the ditch before the redoubts. *u*, lodgements in the redoubts. *x*, bridge of fascines. *y*, batteries against the defences of the bastion A. *z*, batteries to breach this bastion. B, passages over its ditch. C, lodgements in the bastion A. D, lodgements on the border of the ditch before the retrenchment of the bastion A. E, passages over the ditch before this retrenchment.

Fig. 5.

There are places which, without any fore-ditch, have lunettes opposite to the salient and re-entering angles of the glacis, which are also enveloped by a second covert-way: sometimes they are vaulted and bomb-proof, as at Luxemburg; and sometimes they have only a ditch, a parapet, and covert-way. Those which are vaulted and bomb-proof are not easily taken, because the ricochet firing and the bombs can do them no mischief. In that case they must either be turned, or be taken by mines. A work is said to be turned, when the besie-gers

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gers get between that work and the place, and so cut off their communication. Sometimes the lunettes have communication under ground, and then there is scarcely any other way of driving out the enemy but by mines. This is tedious, but there is no other remedy. The lunettes of the ditch are always defended by branches of the covert-way, with which they have also a communication like those of the lunettes, A, A, Plate DLXIII. fig. 1. This plate, which represents part of Landau and its attacks in 1713, may serve to give an idea of the manner in which a work is turned. The advanced lunette B, as well as the work C, called a *tenaille*, is turned; that is, the trenches cut off the communication betwixt them and the place.

Plate DXLIII.

53 Principles to be observed in the attack of fortified places.

We shall conclude this subject of the attack of fortified places, with the following principles to be observed by the besieging army.

The approaches ought to be made, without being seen from the town, either directly, obliquely, or in flank.

No more works should be made than are necessary for approaching the place without being seen; that is, the besiegers ought to carry on their approaches the shortest way possible, consistently with being covered against the enemy's fire.

All the parts of the trenches should mutually support each other, and those which are furthest advanced ought not to be distant from those which are to defend them above 120 or 130 fathoms.

The parallels or places of arms the most distant from the town, ought to have a greater extent than those which are nearest, that the besiegers may be able to take the enemy in flank, should they resolve to attack the nearest parallels.

The trench should be opened or begun as near as possible to the place, without exposing the troops too much, in order to accelerate and diminish the operations of the siege.

There is no such thing as giving any exact rule in regard to the distance which ought to be observed on opening the trenches. On level ground, this distance may be 800 or 900 fathoms; but if there should be a hollow way in the vicinity of the place, the besiegers are to take advantage of it, and open the trenches nearer. In general, they are to regulate themselves according to the nature of the ground, more or less favourable to the opening of the trenches. We shall suppose in the present work, that the opening ought to be made within 800 fathoms of the covert-way; the first parallel within 300 fathoms, the second within 150, and the third at the foot of the glacis.

Care must be taken to join the attacks, that they may be able to support each other.

Never to advance a work unless it be well supported; and for this reason, in the interval between the second and third places of arms, the besiegers should make, on both sides of the trenches, smaller places of arms, extending 40 or 50 fathoms in length, parallel to the others, and constructed in the same manner, which will serve to lodge the soldiers who are to protect the works designed to reach the third place of arms.

The batteries of cannon must be placed in the continuations of the faces of the pieces attacked, to silence their fire, and that the approaches being protected, may advance with greater safety and expedition.

For this reason the besiegers should always embrace the whole front attacked, to have as much space as is requisite to plant the batteries on the produced faces of the works attacked.

The attack must not be commenced with works that lie close to each other, or with re-entrant angles, which would expose the attack to the cross fire of the enemy.

54 General remarks on the defence of fortified towns.

Many circumstances respecting the defence of fortified towns have already been anticipated, or may be collected from what has been said respecting the operations of the besieging army. It is evident that the success or duration of the defence will depend in a great measure on the nature and strength of the works which form the fortification. Much, however, will also depend on the number, resolution, and resources of the garrison, and on the movements of the friendly army by which the besiegers may be opposed. It is estimated by M. Vauban, that the operations for a regular siege of a well fortified town, will take up about 41 days, before the place can be carried by assault. Hence is deduced a computation of the quantity of provisions, ammunition, and stores which ought to be collected for maintaining the siege. The same celebrated engineer calculates that the garrison ought to consist of 600 times as many men as there are bastions in the fortification, allowing 600 men to each bastion. Besides the necessary defence of the works by the cannon on the ramparts, and the musketry of the soldiers, the garrison must make occasional sallies; if weak, to disturb the operations of the besiegers, and if very strong, to engage them in the field. As the siege advances, and the attacking army approaches the glacis, mines should be sprung, and subterraneous passages excavated, to destroy the enemy's works, or cut off a part of their men.

55 Reference to authors on military tactics.

Towards supplying the unavoidable deficiencies in the above sketch of military tactics, we may refer our readers to Clairac's *Field Engineer*, translated by Muller; Le Cointe, *Science des Postes Militaires*, or the English translation; Jeney's work entitled *Le Partisan*, also translated into English; O'Rourke's *Treatise on the Art of War; Essai General de Tactique;* Tielke *on the Art of War*, and his *Field Engineer;* Dundas's *Principles of Military Movements;* Landmann's *Elements of Tactics;* Maizeroy's *Systeme de Tactique;* Archives *Militaires;* Feuquiere's *Memoires;* Bland on *Military Discipline; Military Instructions for Officers detached in the Field;* and the articles BATTALION and BATTLE in Rees's *Cyclopædia.*

PART II. NAVAL TACTICS.

BY naval tactics is understood the art of arranging fleets or squadrons in such an order or disposition as may be most convenient for attacking the enemy, defending themselves, or of retreating with the greatest advantage. Naval tactics are founded on those principles which time and experience have enabled us to deduce from

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from the improved state of modern naval warfare, which has occasioned, not only a difference in the mode of constructing and working ships, but even in the total disposition and regulation of fleets and squadrons.

In the present part we propose to lay down the general principles of naval tactics, and to describe as briefly as is consistent with perspicuity, the most improved systems which are now adopted in the French and British navy. As we have elsewhere (see NAVIGATION and SEAMANSHIP) detailed the methods of working single ships, as they are unconnected with military operations, we shall presume that our readers are already acquainted with these ordinary movements.

56 Ordinary division of fleets.

Fleets are generally divided into three squadrons, the van, centre, and rear, each under the command of a flag officer. The admiral of the fleet, or chief in command, leads the centre division, while the van is usually commanded by a vice-admiral, and the rear by a rear-admiral. Each squadron is distinguished by the position of the colours in the ships of which it is composed. Thus, the ships of the centre squadron carry their pendants at the main-top-gallant mast-head; while those of the van division have their pendants at the fore-top gallant mast-head, and those of the rear at the mizen-top-mast head. Each squadron, as far as possible, consists of the same number of ships, and as nearly as may be of the same force. In large fleets, the squadrons are sometimes again divided in a similar manner; the van and rear of the squadron being headed by rear-admirals, or senior captains, called commodores. In the usual mode of forming the lines, each commanding admiral arranges his ship in the centre of his own squadron, and thus the admiral of the fleet is in the centre of the line. When no enemy is in sight, the sloops, store-ships, fire-ships, and other small vessels, are dispersed to windward of the fleet, that they may be more easily supported, and more readily answer signals. The frigates lie to windward of the van and rear of the convoy, thus keeping a good look-out, and keeping the small vessels in their proper station. When sailing in three columns, the centre still keeps in the middle, while the van and rear form the starboard or the larboard column, according to circumstances. These arrangements are called orders of sailing, and will be better understood from the following definitions.

57 Definitions.

The *starboard line of bearing*, is that line on which the arranged ships of a fleet bear from each other, on a close-hauled line, whatever course they may be steering, so that when the ships haul their wind, or tack together, they may be on a line close hauled upon the starboard tack. The *larboard line of bearing* is that line on which the ships when hauling their wind, or tacking together, may be formed on a line close hauled on the larboard tack. The ships of a fleet are said to be *on a line abreast*, when their keels are parallel to each other, and their mainmasts lie in the same straight line. Ships are said to lie in a line on the bow or quarter, when they are arranged in a straight line, cutting their keels obliquely in the same angle, so that reckoning from any intermediate ship, the ships towards one extremity of the line will be on the bow of that ship, while those towards the other extremity will be on her quarter. When several ships in the same line steer the same course, while that course is different from the line of sailing, they are said to sail chequerwise.

When the ships of a fleet arranged in any of the orders of sailing, and on the same line, perform successively the same manœuvre, as each gets into the wake of the ship that leads the van of the line or squadron, tacking or veering, bearing away or coming to the wind in the same point of the wake of the leading ship, they are said to *manœuvre in succession*.

58 Illustration of the five orders of sailing. Plate DLXIV.

There are usually reckoned five orders of sailing, exclusive of the line of battle, the order of retreat, &c. In the first order (see Plate DLXIV. fig. 1. and 2.) the fleet is arranged on the *starboard* or *larboard* line of bearing, all the ships steering the same course. In these cases the fleet, by hauling the wind when in the starboard line, as in fig. 1. will be ready to form the line on the starboard tack; and when ranged on the larboard line of bearing, as in fig. 2. it will, by tacking, be ready to form the line on the larboard tack. N. B. The arrows annexed to the diagrams on the plates, mark the direction of the wind, as in ordinary charts. Fig. 1. and 2.

This first order of sailing is now seldom employed, except in passing through a narrow strait. In the second order of sailing, the fleet steering any proper course, is ranged in a line perpendicular to the direction of the wind, as in fig. 3. This second order, besides being equally defective with the former, is subject to the additional disadvantage of rendering it extremely difficult for the ships to tack, without each ship falling on board that next a-stern. Fig. 3.

In the third order of sailing, the whole fleet is close hauled, and ranged on the two lines of bearing, so as to form an angle of 12 points, having the admiral's ship (A fig. 4.) in the angular point, and the whole fleet steering the same course. Thus, supposing, as in the plate, the wind at north, the starboard division of the fleet will bear W. N. W. of the admiral, and the larboard E. N. E. This order in small fleets or squadrons, is superior to either of the former; but when the fleet is numerous, the line will be too much extended. Fig. 4.

In the fourth order, the fleet is divided into six or more columns, and is thus more concentrated. The commanders, ranged on the two lines of bearing, have their squadrons astern of them on two lines parallel to the direction of the wind; the first ships of each column being, with respect to the commander of the squadron, the one on his starboard, and the other on his larboard quarter. The distance between the columns should be such that the fleet may readily be reduced to the third order of sailing, and from that to the order of battle. This order is adapted for fleets or convoys crossing the ocean, and is represented in fig. 5. But as it requires much time to reduce a fleet from this order to that of battle, it is defective when in presence of an enemy. Fig. 5.

In the fifth order, the fleet, close hauled, is arranged in three columns parallel to each other; the van commonly forming the weather, and the rear the lee column. See fig. 6. Fig. 7. represents the same order, except that each column is here subdivided into two, with the ship bearing the commander of each squadron in the centre of each subdivision. Fig. 6. and 7.

59 Order of battle.

In forming the order or line of battle, the ships of the fleet are drawn up in a line nearly close hauled, standing

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Plate DLXIV. fig. 8.

standing under easy sail, so that each ship may be at a certain distance from the ship immediately a-head, as a cable's length, or half that distance. The fireships and frigates a-head and astern, form a line parallel to the former, and to the windward of it, if the enemy be to the leeward; but to the leeward if the enemy be to windward. This order is denoted by fig. 8. where the fleet is sailing on the starboard tack, with the wind at north.

60 Order of retreat.

When a fleet is compelled to retreat before a superior force, it is usually arranged in an order, the reverse of the third order of sailing; the divisions of the fleet being ranged in the two lines of bearing, so as to form an angle of 135° or 12 points, the admiral's ship being in the angular point, and the frigates, transports, &c. included within the wings to leeward. See fig. 9. where the fleet is sailing right before the wind. Though any other direction may be taken, the two lines still form the same angle.

Fig. 9.

61 Order of convoy.

The order of convoy is that in which the ships are all in each others wake, steering in the same point of the compass, and forming a right line. If the fleet is numerous, it may be divided into three columns, which are to be ranged parallel to each other, that of the admiral occupying the centre, and all steering the same course.

Having thus described the ordinary positions of a fleet, we must explain the manœuvres by which they are produced, and we shall begin with the orders of sailing.

62 Method of forming the first order of sailing.

To form a fleet in the first order of sailing, supposing the ships to be in no particular order, that ship which is to lead on the proposed line of bearing for the order of sailing, runs to leeward of the greater part of the fleet, and then hauls her wind under an easy sail. Each of the other ships then proceeds to take the proper station, by chasing the ship, which is to be a-head of her, and when in the wake of the leading ship, adjusts her quantity of canvas so as to preserve the proper distance. The ships thus arranged astern of each other, are in the line of battle, and from this the first order of sailing is formed, by each ship bearing away at the same time, and all steering the proposed course.

63 Second order of sailing.

In forming the second order of sailing, the leading ship runs to leeward of so many of the fleet as that each ship may readily fetch her wake, and then steers a course eight points from the wind, under an easy sail. The line is formed by each ship in the same manner as in the first order, except that before bearing away, the line is perpendicular to the direction of the wind, or each ship has the wind on her beam.

64 Third order.

As, in the third order of sailing, the admiral's ship is in the centre; to produce this position, the fleet being formed in a line on one of the lines of bearing, and the ships steering in each others wake, ten points from the wind, the leading or leewardmost ship first hauls her wind. The second ship does the same as soon as she gets into the wake of the former, and this is done by each ship till the admiral's ships haul their wind, when they reach the wake of the leading ship. At the same time that the admiral's ship hauls her wind, the sternmost half of the fleet does the same. The ships are now in the third order of sailing, from which the fleet can be formed in the line of battle on either tack.

To form the fourth order of sailing (see N° 58.), the commanding admirals range themselves on the two lines of bearing, at a proper distance from each other, steering the proposed course, and the ships of the several columns take each their respective places, parallel to each other, and forming lines in the direction of the wind.

65 Fourth order.

66 Fifth order.

To form the fifth order, the three leading ships of the divisions take their posts abreast and to leeward of each other, keeping their wind under an easy sail; then the ships of each squadron make sail, and take their respective stations at the proper distance astern of their leaders, while the commanders of each division, and the corresponding ships of each, keep mutually abreast of each other.

67 To form the line of battle.

In forming from the first order of sailing, if the ships are running large on the tack that answers to the line of bearing on which they sail, and if the line is to be formed on the same tack, all the ships haul their wind at once, or as quickly as possible after the next to windward; but if they be on the other tack, with respect to the line of bearing, they all haul their wind and tack or veer together. If the line of battle is to be formed on the other line of bearing, the ship most to leewards veers or tacks, and hauls her wind, while the rest of the fleet veer or tack at the same time, and steer with the wind four points free, and each ship hauls her wind as soon as she gets within the wake of the leader. See fig. 10. Plate DLXIV. and fig. 1. Plate DLXV.

Fig. 10.

Plate DLXV. fig. 1.

Suppose the fleet running before the wind in the second order of sailing; to form the line from this position, all the ships haul up together on the proper tack, presenting their heads eight points from the wind at the line on which they are arranged; the leading ship then hauls her wind, immediately making sail, or shortening sail, so as to close or open the order, and the same is done successively by all the rest (see fig. 2.).

Fig. 2.

In a fleet running large in the third order, the line of battle is formed by the wing which is in the line of bearing corresponding to the tack on which the line is to be formed, and the ship at the angle, hauling their wind together, while the ships of the other wing haul up together eight points from the wind. Each ship moving in this direction, till she reach the wake of the other wing, when she hauls close up (see fig. 3.).

Fig. 3.

In forming the line of battle on the same tack from the fifth order of sailing (as the fourth is not calculated for forming a line of battle), the centre brings to, so as only to keep steerage way; the weather column bears away two points, and when it gets a-head of the centre, hauls its wind, while the ships of the lee column tack together, and crowd sail to gain the wake of the centre, when they retack together, and complete the line (see fig. 4.); or, the weather column brings to, while the centre and lee tack together, and bear away two points free. When the ships of the centre column have gained the wake of the van, they retack together, and bring to; and when those of the lee have gained the rear line, they retack together, and all stand on; or lastly, the lee column brings to, the centre runs under easy sail two points free, to get a-head of the rear squadron, while the rear bears away under a press of sail two points free, to get a-head of the centre division.

Fig. 4.

2. Suppose the weather and centre columns to interchange. To form the line under these circumstances; the centre stands on, while the weather column bears away 8

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points, and having reached the wake of the centre, which now forms the van, hauls up; the ships of the lee column tack together, and run under a press of sail, within two points free, so as just to gain the rear of the line when they retack together (see fig. 5.), or the lee column brings to, while the centre squadron bears away three points under easy sail; and having reached the wake of the van, hauls up, to form the centre division.

Plate DLXV. fig. 5.

3. Suppose the centre and lee columns to interchange. The lee column stands on close hauled under an easy sail, the weather column bears away to points under a press of sail, till it reach the head of the line, when it hauls up, and the centre bears away eight points, and when in the wake of the lee, now the centre, hauls its wind. (See fig. 6.).

Fig. 6.

4. If the weather and lee columns interchange; the lee column stands on under a press of sail close hauled, while the centre, under easy sail, bears away two points, and when it reaches the wake of the now van squadron, hauls its wind, and the weather column bears away eight points, hauling up when in the wake of the centre. (See fig. 7.).

Fig. 7.

5. Suppose the centre column to form the van, and the weather the rear division. Here the lee column brings to, while the centre bears away two points, forming the line a-head of the former, now the centre, and the weather column veers away seven points on the other tack, forming the rear squadron. (See fig. 1. Plate DLXVI.).

Plate DLXVI. fig. 1.

6. To form the line so that the lee column may form the van, and the centre the rear. The lee column is to stand on under a press of sail, while the weather bears away three points under easy sail, and the centre bears away eight points, the ships of each column hauling their wind, when in the wake of the now van division. (See fig. 2.).

Fig. 2.

7. If the line of battle is to be formed on the other tack, so that the weather shall form the van division, as in the first case, the ships of the weather column first tack successively, while those of the centre and lee stand on, the former under easy sail, and the latter shortening sail, the leading ships tacking when in the wake of the now van, taking great care that the ships of the centre and lee draw not too near to the sternmost ships of the van, or to each other. (See fig. 3.).

Fig. 3.

8. To form the line on the other tack, when the centre and weather columns interchange. The weather column brings to, while the centre column stands on, till the leading ship be fully able to clear the weather column, when the ships of the centre tack successively as they reach the wake of the van. The lee column stands on, tacking successively, as the ships get into the wake of the van, under moderate sail. (See fig. 4.).

Fig. 4.

9. In forming the line on the other tack, when the centre and lee interchange. The centre brings to, while the ships of the weather tack under shortened sail, and the lee under a press of sail stands on, the leading ship having gained the wake of the line, tacks, and is followed in succession by her division. The centre column fills and stands on, when the first ship of that column, and the last of the lee, bear from each other in a direction perpendicular to that of the wind. (See fig. 5.).

Fig. 5.

10. To form on this same tack, so that the weather and lee may interchange. The weather and centre bring to, while the lee crowds sail, till it can pass a-head of the weather column, when the ships tack in succession. As soon as the leading ship of the centre, and the last of the lee bear from each other in a line perpendicular to the wind, the centre fills, and tacks in succession when in the wake of the now van, and the ships of the weather column do the same when their leading ship and the last of the centre are under similar circumstances. (See fig. 6.).

Fig. 6.

11. Suppose the centre is to form the van, and the weather the rear, in forming the line on the other tack. The weather brings to, while the other columns make sail, till they can pass a-head of the former on the other tack, when they tack successively. The weather column, when the others have passed it, fills, and tacks to form the rear. (See fig. 7.).

Fig. 7.

12. Suppose now the lee column is to form the van. The weather and centre bring to, while the lee crowds sail, and tacks when it can pass a-head of the weather column. When the last ship of the now van has passed to windward of the former weather column, the van shortens sail, to give time for the other columns to form, and the weather and centre fill at the same time, to gain the wake of the van, when they tack in succession. (See fig. 8.).

Fig. 8.

68 To form the orders of sailing from the line of battle.

We must now show how a fleet may be disposed in the principal orders of sailing from the line of battle; and here, as before, we have several varieties.

1. To form the first order of sailing from the line of battle on the same tack. All the ships are to bear away together as many points as the admiral may direct, keeping in the line of bearing for the proper tack. The sternmost first bears away, and the others follow in quick succession to prevent running foul of each other.

2. If they are to form on the other tack; the leading ship bears away four points to leeward, and the rest follow in succession. The sternmost ship having bore away, the whole haul up, and will be in bearing for the line on the other tack. (See fig. 9.).

Fig. 9.

3. To form the second order of sailing from the line of battle, the whole fleet is to bear away together 10 points, so that when the headmost ship, which first presses sail, shall come abreast of the second ship, the second ship adapts her sail to keep in this bearing, and so in succession, each taking care to keep the preceding ship in a line with herself, perpendicular to the direction of the wind. The whole fleet will now be before the wind. (See fig. 10.).

Fig. 10.

4. To form the third order, the whole fleet is to bear away together ten points, the headmost half, including the centre ship, carrying a degree of sail to preserve their line of bearing, while each of the remaining ships is successively to shorten sail, so as to form the other line of bearing with respect to that on which they were before arranged. (See fig. 1. Plate DLXVII.).

Plate DLXVII. fig. 1.

5. To change from the line of battle to the fifth order on the same tack. Of this evolution there are several varieties, but we shall mention only two; first, when the van is to form the weather, and the rear the lee column, and the fleet to keep as much as possible to windward.—In this case the van and centre tack together, and run close hauled in bow and quarter line, while the rear proceeds in its former course under easy sail. When each ship of the centre is abreast of the corresponding ship of the rear, the centre retacks, while

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while the van stands on, till the centre and rear come up, when it also retacks, and all the columns regulate their distances. (See fig. 2.). Secondly, when the van is to form the lee, and the rear the weather column.—The van bears away under easy sail, and goes at right angles with the line a-head, while the centre runs two points free, each ship steering for that ship of the van which is to be a-breast of her when in column. The distance must be determined by the leader of the van, who is not to haul up with her division, till she and the sternmost ship of the centre column are in a line at right angles with the wind, when both stand on under easy sail, while the rear crowds sail to pass to windward of both. (See fig. 3.).

Plate DLXVII. fig. 2.

Fig. 3.

6. To form the fifth order of sailing from the line of battle on the other tack—of which there are also several varieties; but we shall confine ourselves to two: First, when the van is to form the weather, and the rear the lee column; the van tacks in succession, while the leading ship of the centre is to tack when the leader of the van passes him exactly to windward, in which she is followed by her division, and the rear manœuvres in the same manner with respect to the centre. (See fig. 4.). Secondly, when the rear is to form the weather and the van the lee column; the van tacks in succession, and when about, either shortens sail, or brings to, to allow the other columns time to form. The centre and rear then crowd sail, and tack in succession, the former tacking when its leader has the centre of the lee column in a line at right angles with the wind, or when its centre passes a-stern of the lee column. When the centre has tacked, it regulates its rate of sailing by the lee, and both wait for the rear to pass to windward. The rear tacks when the leader has the first ship of the lee in a line at right angles with the wind, or when its centre ship passes a-stern of the centre column. (See fig. 5.).

Fig. 4.

Fig. 5.

Fig. 6.

7. Fig. 6. represents the order of retreat formed from the line of battle, the whole fleet going four points free. This evolution is so seldom required in a British fleet, that we need not dwell on it.

69

To manœuvre in line of battle.

There are various evolutions or manœuvres performed by a fleet when in line of battle, some of which we must here describe.

Sometimes the fleet has to form the line on the other tack, by tacking in succession. To do this, the leading ship of the fleet tacks first, after making more sail, or after the second has shortened sail, to increase the interval between them. When the first ship is about, either the second makes more sail, or the third shortens sail, and as soon as the second gets into the wake of the leader, she tacks, putting down the helm just as she opens the weather quarter of the first ship, already on the other tack. In the same manner, each of the other ships tacks when in the wake of the leader; and the ships already about must preserve their proper distances, by shortening sail, if necessary, till the whole fleet be on the other tack. If a ship should miss stays, she must immediately fill again on the same tack, and make sail with all possible expedition, taking care not to fall to leeward. Thus she will get a-head, and to windward of the following ships, which will successively perform their evolutions in the wake of the ships that are already on the other tack, standing on rather further than if the ship a-head had not missed stays. (See fig. 7.).

Fig. 7.

But suppose the ships are not to tack in succession. To form the line on the other tack, the whole fleet veers together; the rear ship hauls her wind on the other tack, and stands on, while the rest go two points free on the other tack, and haul up as they successively gain the wake of the leading ship. (See fig. 8.).

Fig. 8.

If the line is to veer in succession, the van ship veers, and stands four points free on the other tack, hauling her wind when clear of the sternmost ship, and the rest follow and haul up in succession. (See fig. 9.).

Fig. 9.

Sometimes the fleet has to turn to windward while in line of battle. The best way to do this, when there is good sea-room, is for all the ships to tack together, when the fleet will be in a line of battle on the one board, and in bow and quarter line on the other. If, however, the fleet be turning to windward in a narrow channel, it is best for the ships to tack in succession, as, were they all to tack together, the van would be soon in with the land on one side, while the stern ship, soon after the fleet had retacked, would be too near the land on the other side.

If the van and centre are to interchange; the van is to bear away a little, and then bring to, while the centre passess on to windward, edging a little, to get a-head of the former van on the same line; the rear, coming on under an easy sail, edges away likewise, to gain the wake of the now centre squadron. (See fig. 10.).

Fig. 10.

If the van and rear are to interchange; the van and centre are to bear away a little, and then bring to, so that the van may bear away a little more to the leeward than the centre. The rear stands on to gain the head of the line; and when a-breast of the former van, the centre fills, and both standing on, form a-head of the now rear, by edging down till they are in a line with it. (See fig. 11.).

Fig. 11.

If the centre and rear are to interchange; the van stands on under an easy sail, while the centre bears away a little, and brings to, and the rear at the same time carries a press of sail to pass the centre to windward, and get into the wake of the van. The van and centre then edge away to gain the line, with the now rear squadron, which then fills. (See fig. 12.).

Fig. 12.

70

To manœuvre in the fifth order of sailing.

Several evolutions are required while a fleet is in the fifth order of sailing, and of these we shall notice some of the more important.

When the columns are to tack in succession, the ships of the lee must tack first, as they have most distance to run, and when the leader of the centre comes a-breast of the leader to leeward, or at right angles with the close-hauled line on the other tack on which the leader of the lee is now moving, she tacks and is followed successively by the ships of her division. The weather column manœuvres in the same manner, paying the same regard to the centre. Here the weather column is still to windward, and should the columns have closed too much, or be too far asunder, the order may be recovered, either by the lee or windward column bearing away, so as to make an angle equal to that proposed between any column, and a line joining the leader of that column, and the sternmost ship of the next. (See fig. 13.)

Fig. 13.

When all the columns are to tack together; the sternmost ships put in stays together; and when in stays, their seconds a-head put down their helms, and so on through the whole fleet. Each column will then be in bow and quarter line. (See fig. 14.).

Fig. 14.

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Plate DLXVII. fig. 15.

When the columns are to veer in succession; the leader of the lee column must steer four points free on the other tack, followed by the ships of that division, and when she is clear of the sternmost ships of that division, she hauls up. The same evolution is performed by the centre and weather ships successively, standing on till they bring the point at which the lee column began to veer to bear in a right line to leeward of them. They likewise successively spring their luffs when the point at which the lee column hauled its wind, bears right to leeward. (See fig. 15.).

Suppose the fleet, when in the fifth order of sailing is to turn to windward; let the ships be so arranged that the leaders and corresponding ships may be in the direction of the wind. The van ships must tack together, which are followed in succession, each by the remaining ships of the division, when they reach the wake of their leaders, or the same point when they tacked; so that there will always be three ships in stays at once, till the whole fleet is on the other tack. The fleet then stands on to any proposed distance, and retacks as before. (See fig. 1. Plate DLXVIII.).

Plate DLXVIII. fig. 1.

When the weather and centre columns interchange; the weather and lee lie to, or only keep steerage way. The centre column tacks together, and forming a bow and quarter line, goes close hauled to gain the wake of the weather column; it then tacks together, and stands on, while the weather column bears away to its new station in the centre, and the lee column fills. (See fig. 2.).

Fig. 2.

When the weather and lee columns are to interchange; the centre column must bring to; while the lee stands on under a press of sail; and when its sternmost ship can pass to windward of the van of the centre column, that is, when the centre ship of the lee is in a perpendicular line to the direction of the wind with the van of the centre column, the lee column then tacks together, and stands on close hauled till it comes in a line with the centre column, when it goes large two points to get into the situation which the weather column left; and then veers together, hauling the wind for the other tack. At the beginning of the evolution the weather column bears away together under little sail, and goes large six points on the other tack, to get into the wake of the centre column; it then hauls to the former tack, going two points large, till it comes abreast of the centre column, when it brings to, and waits for the now weather column. (See fig. 3.)

Fig. 3.

Suppose the weather column is to pass to leeward; the weather column is to stand on under easy sail, while the centre and lee tack together, carrying a press of sail till they reach the wake of the weather column, when they retack, and crowd sail till they come up with it. The weather column, when the others have gained its wake, bears away two points, to gain its station to leeward, when it brings to, till the other columns, now the weather and centre, come up. (See fig. 4.).

Fig. 4.

Suppose the lee column is to pass to windward. The weather and centre columns bring to, while the lee column carries sail and tacks in succession as soon as the leading ship can weather the headmost ship of the weather column; and when arrived on the line on which the weather column is formed, it retacks in succession, forms on the same line, and either brings to or stands on under easy sail. If it brings to, the other two columns bear away together two points, to put themselves a-breast of the column now to windward; but if the now weather column stood on under an easy sail, they may bear away only one point, to gain their proper stations: (See fig. 5.).

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Fig. 5.

It is of the greatest importance that each ship of a fleet or squadron preserve her proper station and distance with respect to the rest. These may be regulated in two ways, either by observation with the quadrant, or by what is called the *naval square*. This square is usually constructed in the following manner.

71 Construction and use of the naval square, fig. 6.

On some convenient place in the middle of the quarter-deck is described the square ABCD, fig. 6. having the sides AD and BC parallel to the keel of the ship. Through the centre G, the line EF is drawn parallel to AD or BC, and the diagonals AC and BD are drawn. The angles EGD, EGC are bisected by the straight lines GH, GI, and thus the naval square is completed. Now the angles FGD, FGC are = 4 points each, being each half a right angle, therefore the angles EGD, EGC, the complements of these angles, are each = 12 points, and consequently the angles EGH, EGI are each = 6 points, being each half of the last angles. Now, if a ship be running close hauled on the starboard tack, in the direction FE, the direction of the wind will be IG, and her close-hauled course on the other tack will be GC; but if she be running close hauled on the larboard tack in the same direction, her direction when close hauled on the starboard tack will be GD.

Now, to apply the naval square to the keeping of ships in their respective stations, suppose the fleet formed on the fifth order of sailing, close hauled, the corresponding ships of the columns coinciding with the direction of the wind, in order to run to windward with greater facility. The corresponding ships in the column must be kept in the direction of GH, or GI, according to the direction of the wind and the tack they are on, while all the ships of the same column must be in the direction of EF. (See fig. 7.). Fig. 7.

Again, suppose the ships arranged in three columns on one of the lines of bearing, and close hauled on the other tack. The ships of each column will be in the direction of one of the diagonals, while the corresponding ships of the other columns will be in the direction of the other diagonal. (See fig. 8.). Fig. 8.

72 To restore the order of battle, on shifts of the wind.

Sometimes the line of battle is disordered on the wind's shifting, and requires to be restored. Of this there are several cases, a few of which we shall notice.

1. When the wind comes forward less than 6 points. In this case the whole fleet except the leader brings to. The leading ship, that the same distances between the ships may be preserved on restoring the line, steers a course as *a b* (fig. 9.), so as to be at right angles with the middle point between the former and present direction of the wind. His required course may be known by adding half the number of points the wind has shifted to eight points, and applying this sum to the former close-hauled course. When the leader has arrived at the new close-hauled line with respect to the second ship a-head, this ship immediately fills, and bears away as many points as the leader; and when both these have reached the close-hauled line with respect to the third ship, she also fills, and bears away; and thus with the rest in succession; and when they have got into the close-hauled Fig. 9.

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close-hauled line *b c* with the sternmost ship, they all haul their wind together, and the sternmost ship fills and stands on close hauled.

Plate DLXVIII. This may be expeditiously performed, if the whole fleet fall off as soon as the wind shifts, the same number of points, and the leader bear away eight points from the middle between the former and present directions of the wind, or when the wind shifts nearly six points, if the leader bear away eight points from the present direction of the wind, and hauls her wind as soon as the sternmost ship bears from her in the close-hauled line, while the second ship bears away when she reaches the wake of the leader, and hauls her wind when she has again gained his wake. The third, fourth, &c. ships bear away, and also haul their wind in succession, till the sternmost and the whole line be formed again. (See fig. 10.)

Fig. 10.

2. Suppose the wind comes forward less than six points, and the order of battle is to be re-formed on the other tack. In this case all the ships are to veer round till their heads come to the requisite point with respect to their former course, when the rear ship, now become the van, hauls close by the wind, followed successively by the other ships. Should the wind come a-head more than six points, but less than twelve, the fleet is to manœuvre as before, but if it shift exactly twelve points a-head, the tack must be changed.

3. Lastly, suppose the wind to shift oft—if less than two points, the leader hauls her wind, while the fleet stands on as before, each successively hauling her wind as she gains the wake of her leader. If the tack is to be changed, the whole fleet tack together, and the sternmost ship, now the leader, hauls up, while the rest bear down and haul up in succession.

Should the wind change 16 points, all the ships immediately brace about for the other tack, by which means the fleet will be going four points large; then the ships instantly tacking or veering together, the order of battle will be restored or formed again on the same tack as before the wind changed.

It is inconsistent with the nature of our plan to be more minute on the various evolutions of a fleet, when not in action with the enemy. Our nautical readers will find abundant information of this kind in the usual works on naval tactics, especially the *Elements and Practice of Rigging, Seamanship, Naval Tactics*, &c. of which the latest edition is in 4 vols 8vo.; and *The System of Naval Tactics, with coloured figures*, both published by Steel.

Having described and illustrated the principal evolutions which are performed by fleets or squadrons under ordinary circumstances, we are prepared to consider the nature and consequences of a naval engagement.

73 Circumstances to be considered in forming a fleet for action.

In forming a fleet for battle, it is proper to consider the size and number of the ships of which it is to consist, and the distance at which they are to be placed with respect to each other. In the present system of naval warfare, it is generally deemed of advantage to have the ships that are to form the principal line as large as possible; for though large ships are not so easily and expeditiously worked as those of a smaller size, they are most serviceable during the action, both as carrying a greater weight of metal, and as being less exposed to material injury, either from the enemy's shot, or from the weather. In boarding, too, a large ship must have greatly the superiority over a smaller, both from her greater height, and from the number of hands which she contains. With respect to the number of ships, it is of advantage that they be not too numerous, as if the line be too extensive, the signals from the centre are with difficulty observed.

In arranging a fleet in line of battle, it is proper to regulate the distance so that the ships shall be sufficiently near to support each other, but not so close as that a disabled ship may not readily be got out of the line without disturbing the rest of the fleet.

74 Advantages and disadvantages of the weather gage.

It has long been deemed a point of great consequence with the commander of a fleet to gain the weather gage, or to get to windward of the enemy, before coming to action. In deciding on the propriety of this, much will depend on the relative strength of each fleet, and on the state of the weather at the time. We shall state the advantages and disadvantages of the weather gage, as they are commonly laid down by writers on naval tactics, though we may observe by the way, that if a fleet be much superior to its opponent, it is seldom of consequence whether it engages to windward or to leeward.

A fleet to windward of the enemy is thought to possess the following advantages. It may approach the leeward fleet at pleasure, and can of course accelerate or delay the beginning of the engagement. If more numerous, it may send down a detachment on the rear of the enemy, and thus throw him into confusion. It may also readily send down fireships on the enemy's fleet, when thrown into confusion or disabled. It may board at any time, and is scarcely incommoded by the smoke of the enemy. The reverse of these circumstances, of course, act against a leeward fleet.

The disadvantages of being to windward of the enemy respect chiefly the circumstances attending a retreat, should this be necessary. The windward fleet can seldom retire without passing through the enemy's line; and if in attempting to retreat, the windward ships tack together, those of the leeward fleet may do the same, rake the weather ships in stays, and follow them on the other tack, having now the advantage of the wind. In stormy weather, the windward ships can seldom open their lower deck ports, and the lee guns are not easily managed after firing. Again, any disabled ships cannot easily quit the line without disordering the rest of the fleet, and exposing either that or themselves to be raked by the enemy to leeward. A leeward fleet has the advantages of serving their lower deck guns in all weathers; of being able to retreat at pleasure; of drawing off without difficulty their disabled ships; of forming with more readiness the order of retreat; or of continuing the action as long as convenient; of having it in their power, when superior in number, to double the enemy, and of cannonading with great effect the windward ships as they bear down for the attack.

As an engagement between two adverse ships is in some measure an epitome of an engagement between two fleets, we shall first briefly describe the former, as it takes place under ordinary circumstances, and shall then notice the usual manner of conducting a general engagement.

A naval engagement may be divided into three stages, the *preparation*, the *action*, and the *repair*.

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75 Description of an engagement between two ships.

76 Preparation.

When an enemy's ship heaves in sight, and it is thought advisable to bring her to an engagement, orders are first given to clear for action, which is begun by the boatswain and his mates piping up the hammocks, in order to clear the space between decks, for the more easy management of the guns, as well as to afford the men on the quarter-deck, &c. a better protection against the enemy's shot, the hammocks being stowed in the nettings above the gunwale and bulwarks. After this, the boatswain's mates go to work to secure the yards, which is done by fastening them with strong chains or ropes in addition to those by which they are suspended. They likewise get ready such materials as may be necessary for repairing the rigging, if it should be cut away, or otherwise damaged by the enemy's shot. In the mean time the carpenter and his mates prepare shot plugs and mauls, to stop any dangerous shot holes that may be made in the hull near the surface of the water, and provide the necessary iron work for refitting the chain-pumps, if their machinery should be injured during the engagement; while the gunner and his mates, and the quarter gunners, examine the guns, to see that their charges are dry, and provide every thing that may be required for supplying the great guns and small arms with ammunition. The master and master's mates see that the sails are properly trimmed, according to the situation of the ship, and increase or reduce them as may be found necessary; and the lieutenants visit the different decks, to see that all is clear, and to take care that the inferior officers do their duty.

When the hostile ships have approached within a proper distance of each other, the drums beat to arms; the boatswain and his mates pipe *all hands to quarters!* All the men who are to manage the great guns repair immediately to their respective stations. The crows, handspikes, rammers, sponges, powder-horns, matches, and train tackles, are placed in order by the side of the guns: the hatches are immediately closed, to prevent skulkers from getting below; the marines are drawn up on the quarter-deck, &c. the lashings of the guns are cast loose, and the tompions withdrawn. The whole artillery, above and below, is run out at the ports, and levelled to the point-blank range, ready for firing.

77 The action.

When these necessary preparations are completed, and the officers and crew ready at their respective stations, and when the two ships are sufficiently near each other, in a proper relative situation for the shot to take full effect, the action commences with a vigorous cannonade from the great guns, accompanied by the whole efforts of the swivels and small arms. The firing is seldom performed in vollies, as that would shake the ship too much, but the guns are loaded and fired one after another, with as much dispatch and as little confusion as possible, care being taken to fire only when each gun is properly directed to its object. During the firing, the lieutenants traverse the decks, to see that the battle is prosecuted with vivacity, and that the men do their duty, while the midshipmen second their injunctions, and give the necessary assistance where required, at the guns committed to their charge. The youngest of these inferior officers are generally employed to carry orders from the captain. The gunners are all this time employed in the magazines, filling cartridges, which are carried along the decks in boxes by the boys of the ship. When the action has continued so long, or has produced such an effect, that one of the ships must yield or retreat, if the vanquished ship cannot get off, she acknowledges her inferiority by striking, or hauling down her colours, when she is, as soon as possible, taken possession of by the victor, the commander of which sends a part of his own crew into the captured ship, and brings away most of her officers and men on board his own ship, as prisoners of war.

78 Repair.

The engagement being concluded, they begin to repair; the guns are secured by their breechings and tackles, with all convenient expedition. Whatever sails have been rendered unserviceable are unbent, and the wounded masts and yards struck upon deck, to be fished or replaced by others. The standing rigging is knotted, and the running rigging spliced where necessary. Proper sails are bent in the room of those which have been displaced as useless. The carpenter and his mates are employed in repairing the breaches made in the ship's hull, by shot plugs, pieces of plank, and sheet lead. The gunner and his assistants are busied in replenishing the allotted number of charged cartridges, to supply the place of those which have been expended, and in refitting whatever furniture of the guns may have been damaged by the action.

79 Engagement between two fleets.

A general engagement between two adverse fleets of course involves a greater variety of circumstances, and requires greater judgment, and more comprehensive skill in the commanding officer.

When the commander of a fleet has discovered an enemy's fleet, his principal object, if he be sufficiently strong, is to bring it to action as soon as possible. Every inferior consideration gives way to this important object, and all necessary preparations are immediately made to prepare for such an event. The state of the wind and situation of the enemy will in general regulate his conduct with regard to the disposition of his ships on that occasion. To facilitate the execution of the admiral's orders, the whole fleet is disposed in three squadrons, and each of these classed into three divisions, under the command of different officers. Before the action begins, the adverse fleets are drawn up in two lines, as formerly described. As soon as the admiral displays the signal for the line of battle, the several divisions separate from the columns in which they were disposed in the usual order in sailing, and every ship crowds sail to get into its station in the wake of the next ahead; and a proper distance from each other is regularly observed from the van to the rear. The admiral, however, occasionally contracts or extends his line, so as to regulate the length of his line by that of his adversary. This is more particularly necessary to prevent his being doubled, by which his van and rear would be thrown into disorder. When the hostile fleets approach each other, the courses are commonly hauled upon the brails, and the top-gallant sails and stay sails furled. The movement of each ship is regulated chiefly by the main and fore-top sails and the jib: the mizen-top sail being reserved to hasten or retard the course of the ship; and by filling or backing, hoisting or lowering it, to determine her velocity. The signal for a general engagement is usually displayed when the fleets are sufficiently near each other, to be within the range of point-blank shot, so that the guns may be levelled with some certainty of execution. After the battle has commenced, it is carried on much in the same manner as between two ships, except that each vessel

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vessel of the fleet, besides attending to her own movements, has to observe the signals made by the commanding officer, and repeated by the frigates on the van and rear. The chief object of the admiral is to keep his line as complete as possible, by ordering ships from those in reserve to supply the place of such as may have been disabled, and to annoy the enemy as much as possible, both by strengthening the feeble parts of his own line, and, if circumstances admit of it, by sending down fire-ships upon that of the enemy. When the engagement draws near a close, either by the defeat of the enemy, or by the disabled state of either fleet, signals are made from the admiral to take possession of such of the enemy's ships as have struck, to tow his own disabled ships into a place of security, and either to chase the remainder of the enemy's squadron, or, if that be impracticable, to draw off his own ships to be refitted. *

Such are the general incidents attending an engagement at sea, modified of course by numerous circumstances, of which a general description can convey no idea. There are, however, various movements and evolutions connected with a naval engagement, which it will be necessary for us to notice.

* For particular British naval actions, see *Campbell's Lives of the Admirals*, and *Beatson's Naval and Military Memoirs of Great Britain.*

80
To dispute the weather gage with an enemy.

Where the weather-gage is deemed of sufficient importance, it is often an object with two fleets to dispute it with each other. When the enemy is to windward, and it is wished to gain the weather-gage of him, the fleet to leeward should avoid extending itself the length of the enemy's line, in order to oblige them to edge down upon theirs, if they intend to attack them; which will be a mean, if they still persist in doing so, of losing the advantage of the wind. It is impossible for a fleet to leeward to gain to windward, so long as the enemy keep the wind, unless a change happens in their favour; therefore all that a fleet to leeward can do must be to wait with patience for such a change, of which they will undoubtedly avail themselves, as well as of any inadvertency the enemy may commit in the mean time. And as long as the fleet to leeward does not extend its line the length of the enemy's, it will be impossible for the latter to bring them to action without running the hazard, by bearing down, of losing the advantage of the wind, which both fleets will be so desirous of preserving. That an admiral may take advantage of such shifts of wind as occasionally happen, he must endavour to get his ships into such situations where these shifts most frequently take place. It is well known to experienced naval officers, that particular winds reign most on certain coasts, or off certain headlands. Here, therefore, the admiral should await the approach of the enemy; and though by this plan he may sometimes be unsuccessful, he will more frequently gain a material advantage. The disposition of projecting headlands, and the setting of tides and currents, often contribute materially towards gaining the wind of the enemy. The fleet to windward should keep that to leeward as much as possible abreast of it; and thus unless the wind changes considerably, they will preserve the advantage they have gained. They should also force them to keep their wind, unless they think it prudent not to engage, in which case it would be better to keep altogether out of sight.

81
To force the enemy to action.

When the enemy appears desirous of avoiding an action, there are various methods of attempting to force him to engage; as first, when he has the weather gage. In this case the lee fleet, which is desirous of bringing on an engagement, must keep always on the same tack with the enemy to windward, taking care to keep their own ships so exactly abreast of the enemy, as to prevent losing sight of them; and hence be ready to take advantage of the first favourable shift of wind to make the attack. An alteration of the course may be best attempted in the night. The lee fleet must have frigates on the look-out, and these must continually give notice by signal of the manœuvres and course of the retreating fleet to windward. Thus the weather fleet is always exposed to pursuit, without being able to get off unseen; hence must sooner or later be compelled to an engagement, unless they can get into some friendly port, or should be favoured by a gale of wind sufficient to disperse both fleets, and thus prevent the possibility of a general engagement.

Secondly, when the enemy is to leeward.—If the lee fleet keep close to the wind in the order of battle, the fleet to windward is to stand on in the same manner till it be abreast of the enemy, ship to ship, and at the same time to bear away, and steer so as to bring their respective opponents on the same point of the compass with themselves. Thus the adverse fleets will be sufficiently near each other to begin the action, by each ship's presenting her bow to the ship abreast of her in the order of sailing, which may be easily changed for the order of battle, by all the ships hauling together close to the wind, in the moment which precedes the action. If the fleet to leeward appear inclined to engage, it may bring to, to prevent losing time, and after this they will fill as soon as the action commences, because it is of advantage to a lee line to be advancing a-head. As the lee fleet fills and stands in close by the wind, the weather line should keep a-breast, before it bears away, to come within the requisite distance, that the van ship of the weather fleet may always keep to windward of the leading ship of the lee line, and be guarded against any shift of wind a-head.

If the lee fleet bear away four points to move their order of battle on the other tack, and avoid the action, filing off in succession in the wake of the van ship, the weather line, by bearing away all together eight points, cannot fail, as both fleets are supposed to sail equally, to pass through the middle of their line, and force them to fight with disadvantage, if their extent be double the distance between the two fleets. If the extent of the fleet be less than the above limitation, then the weather fleet will divide the lee fleet more unequally; and if the distance between the fleets be considerable, the weather fleet will be able to break through the line. If the lee fleet bear away four points all together, being of equal extent with the fleet to windward, and their distance from each other equal to that of the length of one of the lines; should the weather fleet bear away at the same time eight points, they will approach very near the sternmost of the retreating fleet; but they will not have it in their power to cut off any part of that fleet, even with an equality of sailing; so that the only advantage gained by this manœuvre will be an ability of attacking the rear, and bringing it to action.

If the van ship and the rest of the weather fleet had a sufficient velocity to keep the centre ship of the lee line on the same point of bearing; in that case, the leading ship may break through the enemy's line about the middle

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middle ship of the centre division; for, supposing the fleets in the order of battle, on the starboard tack, steering east, with the wind at south-south-east, being at two leagues distance from each other, both the lines being four leagues in extent; then the lee line bearing away all together four points, will run north-east; while the fleet to windward, bearing away all together eight points, will steer north; the van ship of which will keep the centre division of the lee line in the point of bearing north-west. As she is supposed to be able to continue in this position, it follows, that the van of the weather line must close the centre of the flying line to leeward, after having run four leagues. The time and distance necessary to cut off a retreating fleet may always be known according to the last supposition. If the lee fleet should get on the other tack, and run large, still in the order of battle, they will be sooner forced to action by the weather fleet, who have only to bear away eight or nine points on the same tack, or run right before the wind.

81 To avoid coming to action.

As in forcing a fleet to action, there are two principal cases in which a fleet may avoid an action, where circumstances are not sufficiently favourable; first, when the enemy is to windward, and secondly, when he is to leeward. In the former case the lee fleet should form the order of retreat, if the enemy are in view, and run on the same tack as their leading ship; but if he is still out of sight, and they have received intelligence of his approach, by their frigates on the look-out, they may bear away large, without confining themselves to keep the wind directly off, unless when in the order of retreat. In the second case, it seldom happens that the weather fleet can be forced to an engagement, because it can always stand on that tack which increases its distance from the enemy; that is, by standing on one tack while the enemy is on the other. The windward fleet must of course not keep too near the enemy, and take all possible means of avoiding being abreast of him.

82 To double an enemy.

It is often of advantage to double the enemy; that is, to bring a part of the fleet round upon his van or rear so as to place him between two fires. This manœuvre also resolves itself into two principal cases; first, when the enemy is to windward; secondly, when he is to leeward. In the first case, the lee fleet that attempts to double the enemy, should extend itself abreast of him, so that its van or rear may extend beyond his line, in order to overreach him, by tacking in succession, so that the extended part of the line may get up to windward. If this manœuvre be properly executed, it will be impossible for the ships of the weather line long to maintain their stations, for no vessel closely attacked by two others of equal force can long resist.

It is of some consequence to determine whether the attempt to double should be made on the van or the rear of the enemy, as on the propriety of adopting the one or the other of these measures, may in a great measure depend the issue of the battle. In the present case, it is most easy to double the van of the enemy, because if they are engaged by the ships abreast of them, those which are advanced ahead will be able, by making all sail, to get in the perpendicular to the direction of the wind with the van of the enemy, and tack in succession to gain the wind of them on the other board, thus keeping them to leeward; and when they are come sufficiently to windward, they are again to go about, in order to keep the two headmost ships of the enemy's line continually under their fire. If there be two or three ships to tack in succession and gain the wind of the enemy, they may edge down on the van of the water line at pleasure, keeping themselves a little to the windward of it; and as that van is already engaged by the other ships abreast on the other side, she must necessarily be soon disabled. If they bear away, they must drop upon the line with which they are engaged to leeward, while the ships to windward still continue to cannonade them. If they attempt going about, in order to attack more closely the ships to windward, they will be raked, while in stays, by their opponents to leeward and to windward, who enfilading them with whole broadsides which they cannot return, must complete their disorder. If they make sail, in order to frustrate the design of the ships inclined to double, those with which they are engaged abreast to leeward have only to perform the same manœuvre, and keep them under their fire; while the others, after having harassed them as much as possible, will do their best to perform the same manœuvre on the succeeding ships.

If any of the ships in the van of the weather line are disabled in the masts or yards, they will drop astern, and run foul of the next succeeding ship, and these again on the next astern. Thus, the enemy's order of battle will be broken, while on the other hand the lee line is preserved; and those ships which have gained the wind of the enemy will, without engaging more ships than they can manage, contribute to increase the confusion.

When the enemy is to leeward, and the weather fleet attempts to double, the ships of the weather line must extend their van beyond that of the enemy, and then veer in order to bring the headmost ships of the lee line between two fires. It must not, however, be concealed, that it is much more dangerous to the ships engaged in this service to attempt doubling a fleet to leeward, than one to windward, as if disabled, or separated too far from their own fleet, they cannot so easily extricate themselves, and rejoin the fleet.

83 To avoid being doubled.

When one fleet attempts to double another, this latter will of course do all in their power to avoid the impending danger; and this they will the more readily do, according to their number, or their situation. If the fleet thus threatened be to windward, one of the methods proposed to avoid being doubled, is to extend the line towards the point threatened, so as to leave a greater space between the ships; but in doing this, there is a risk of having the line broken by the superior enemy. Another method suggested is, for the flag ships of the windward fleet to oppose themselves to those of the lee line, which is supposed to render several of the enemy's ships in the intervals of little use; but one great inconvenience of this manœuvre is, that it leaves the van and rear most exposed to the enemy's fire, and that the rear division in particular is in great danger of being doubled. To remedy these defects, the largest ships should be placed in the van and rear of each division, and the fleet must regulate its sailing in such a manner that its rear shall never be astern of the rear of the enemy.

When the enemy is to leeward, the weather fleet is to keep astern of the enemy, so that the van of the weather fleet, may be opposed to, and attack the enemy's centre. Hence the enemy's van will become useless for some

some time; and should it attempt to tack and double on the weather fleet, much time will be lost in performing that evolution; and it also runs the risk of being separated by the calm which often happens in the course of an engagement, occasioned by the discharge of the guns. A considerable interval might also be left between the centre and van, if necessary precautions be taken to prevent the van from being cut off.

84 Of chasing.

There are several circumstances of importance to be considered in the subject of chasing, i. e. when one ship or fleet pursues another, called the *chase*, either to bring her or them to action, or to oblige them to surrender.

85 In the case of single ships.

When a single ship chases another, it is to be presumed in general, that one of them is the better sailor, though this is not always the case, and still by proper manœuvring the chasing ship, or *chaser*, may gain on the chase. In the following observations, however, we shall suppose the chaser to sail faster than the chase. The manœuvres of the chaser will depend on her being to windward or leeward of the chase.

When the chase is to windward, it is evident that as soon as she perceives a strange ship which she takes for an enemy, she will haul her wind, in order to prolong the chase, as otherwise her retreat would soon be cut off. The chaser then stands on also nearly close hauled, till she has the chase on her beam; she then tacks, and stands on close hauled till the chase is again on her beam, and then retacks. In this manner she continues tacking every time she brings the chase perpendicular to her course on either board; and by thus manœuvring, it is certain that the chaser will, by the superiority only of her sailing, join the other in the shortest time. For since the chaser tacks always as soon as the chase is perpendicular to her course, she is then at the shortest distance possible on that board; and since the chaser is supposed to be the fastest sailer, these shortest distances will decrease every time the chaser tacks. It is therefore of advantage to the chase to keep constantly on the same course, without losing her time in going about, as tacking cannot be so favourable to her as to her adversary, whose sailing is superior. If the captain of the chaser should so little understand his profession as to stand on a long way, and tack in the wake of the chase, the best thing she can do is to heave in stays, and pass to windward of him on the other tack, except she should find herself likely gaining advantage by going large; for if the chaser persists in tacking in the wake of the other ship, the pursuit will be very much prolonged.

When the chase is to leeward, the chaser is to steer that course by which she thinks she will gain most on the chase. If, after having run a short time, the chase is found to draw more aft, the chaser should then bear away a little more; but if the chase draw a head, the chaser should haul up a little, and thus the course may be so regulated, that the chase may always bear on the same point, and then the chaser will get up with the chase in the shortest time possible; for if any other course were steered, the chaser would be either too far ahead or too far astern, and hence the pursuit would be prolonged. The chase should run on that course which will carry her directly from the chaser, and should consider which is her best trim with respect to the wind, that she may move with the greatest possible rapidity from the chaser; for some ships have more advantage in going large, others with the wind right aft, and others when close hauled.

Another method has been proposed for chasing a ship to leeward, that is, by constantly steering directly for the chase: in this case, the tract described by the chaser is called the line or *curve of pursuit*. To illustrate this, let A (fig. 11. Plate DLXVIII.) represent the chaser, and B the chase directly to leeward of her, and running with less velocity than the pursuer, in the direction BC, perpendicular to that of the wind. Now, to construct this curve, let B *b* be the distance run by the chase in any short interval of time; join A *b* and make A 1 equal the distance run by the chaser in the same time. Again, make *b c*, *c d*, *d e*, *e f*, &c. each equal to B *b*; join 1 *c*, and make 1, 2=A 1; join 2 *d*, and make 2, 3 equal to A 1; proceed in like manner till the two distances carried forward meet as at C, and a curve described through the points A, 1, 2, 3, &c. will represent nearly the curve of pursuit; and the less the interval A 1 is taken, the more accurately will the curve be formed. In this particular case, the length of the distance BC may be found as follows, provided the distance AB and the proportional velocities of the two ships be known. 86 Curve of pursuit. Plate DLXVIII. fig. 11.

Let the velocity of the chase be denoted by a fraction, that of the chaser being unity. Multiply the given distance AB by this fraction, and divide the product by the complement of the square of the same fraction, and the quotient will be the distance run by the chase B. Suppose AB, the distance of the chase directly to leeward of the chaser, be taken at 12 miles, and suppose the velocity of the chase three-fourths of that of the chaser; what will be the distance run by the chase before she is overtaken? Now $\frac{12\times\frac{3}{4}}{1-\frac{3}{4}|^2}=\frac{9}{\frac{7}{16}}=9\times\frac{16}{7}=20\frac{4}{7}$ miles; and since the velocity of the chaser to that of the chase is as 4 to 3, hence the distance run by the chaser will be $=20\frac{2}{7}\times\frac{3}{4}=27\frac{3}{7}$ miles. As the chaser alters her course at every point, and probably sails better with the wind in one direction with respect to her course than when the wind is in another direction, her velocity will be different at different points of the course. Thus, suppose her to sail faster when the wind is on the quarter, her velocity will constantly increase to a certain point, and will then diminish. Hence in real practice the curve of pursuit will not be exactly what is laid down in the above problem, and of course the measure of BC will differ a little from what we have there laid down. See *Resistance of Fluids* and Seamanship.

If the whole fleet is to give chase, the admiral will make the proper signal, and then each ship will instantly make all the sail possible. If the retreating fleet is not much inferior to the other, a few of the fastest sailing vessels only are to be detached from the superior fleet, in order to pick up any stragglers, or those ships which may have fallen astern; and the remaining part of the fleet will keep in the same line or order of sailing as the retreating fleet, so that they may, if possible, force them to action. But if the retreating fleet is much inferior, the admiral of the superior fleet will make the 87 In the case of fleets.

 signal

signal for a general chase, and then each ship will immediately crowd all the sail possible after the retreating fleet; or, if the chase be still less numerous, the admiral will detach one of the squadrons of his fleet, by hoisting the proper signal for that purpose, and he will follow with the remainder of the fleet. The squadron that chases, should be very careful not to engage too far in the chase, for fear of being overpowered; but at the same time to endeavour to satisfy themselves with regard to the object of their chase. They must pay great attention to the admiral's signals at all times; and in order to prevent separation, they should collect themselves before night, especially if there be any appearance of foggy weather coming on, and endeavour to join the fleet again. The ships are diligently to observe when the admiral makes the signal to give over chase; that each regarding the admiral's ship as a fixed point, is to work back into her station, to form the order of line again as quickly as the nature of the chase and the distance will permit.

When a fleet is obliged to run from an enemy who is in sight, it is usual to draw up the ships in that form or order, called the *order of retreat;* and the admiral, when hard pursued, without any probability of escaping, ought, if practicable, to run his ships ashore, rather than suffer them to be taken afloat, and thereby give additional strength to the enemy. In short, nothing should be neglected that may contribute to the preservation of his fleet, or prevent any part of it from falling into the hands of the conqueror.

We have now gone through the principal evolutions of fleets and squadrons, nearly as they are described in the *Elements of rigging, seamanship, and naval tactics,* and other approved publications on similar subjects. We have indeed omitted the method of forcing an enemy's line, and of avoiding being forced, because the former will be readily understood from what we have to add on the improved method of tactics of M. Grenier, and Mr Clerk of Eldin.

88
Defects of the usual line of battle.

Various defects have been observed in the tactics usually employed at sea, especially in a line of battle, and in the mode of bringing an enemy to action. The usual order of battle first introduced by the duke of York, afterwards James II. of England, is defective from its length. Its great extent makes it difficult for the admiral to judge what orders are proper to be issued, to the ships stationed at the extremities, while his signals, however distinctly made, are liable to be mistaken by the commanders of these ships. Besides, the extremities of a long line, especially if it be to leeward, are necessarily defenceless, as the enemy may throw himself with a superior force on the van or rear, and cut either of these off before it can be properly supported by the other squadrons. Viscount de Grenier, who was, we believe, one of the first to notice these defects, proposed to remedy them by introducing a new order of battle.

89
Principles of de Grenier's method of tactics.
Plate DLXVIII. fig. 12.

The leading principles of De Grenier's tactics are founded on the following considerations. It is evident that each ship of a fleet must at all times occupy the centre of a certain horizon. This horizon De Grenier divides into two unequal parts, calling the greater the *direct and graduated space,* and the less the *indirect, crossed, and ungraduated space.* The reason of these appellations is, that on the greater segment of the horizontal circle there are 20 different points, which may be marked by degrees from one of the close-hauled lines to the other, and to which a ship may sail from the centre by so many direct courses without tacking; whereas from the other 12 points, including that from which the wind blows, she cannot arrive but by steering cross courses, which must necessarily delay her progress. Suppose now a fleet to leeward, so disposed that only a part of it can fight with another equally numerous, and ranged to windward in a single line, and let the lee fleet be ranged on three sides of a lozenge *a b, c d, e f,* (fig. 12.). The squadron *a b,* which is most to windward, being drawn up in line of battle, cannot be fought but by an equal number AB, CD, EF. All the rest of that fleet therefore must remain inactive, unless the ships which are not engaged should try to pass to leeward of the fleet *a b, c d, e f.* But should the ships of the weather fleet, which are placed between B and F, bear away as they appear in the figure between C *i* and F *i,* the ships between A and B, which are fighting to windward, cannot bear away with them. Suppose now that the ships between C *i* and F *i* have passed to leeward, the squadrons *c d, e f,* which are ranged according to De Grenier's system, and have not yet been engaged, should come to windward and join with their friends *a b* against that squadron of the enemy AB which is still to windward and engaged; it is almost impossible but that the squadron AB must be destroyed by so great a superiority, before it could receive assistance from the ships to leeward between C *i* and F *i.*

90
His orders of sailing.

De Grenier proposes only three orders of sailing, one when a fleet is to pass a strait; a second when it steers in open sea, on the look-out for an enemy, or with a view to avoid him; and a third when on an extensive cruise disposed so that it cannot be easily suprised or broken. Of these three orders, only the second and third differ from the usual orders of sailing. The former of these is represented by fig. 1. Plate DLXIX. where the columns *a b, c d, e f,* are disposed on three sides of a regular lozenge, on the two close-hauled lines. The ships of the two divisions *c d, e f,* sometimes to windward (as in fig. 2.) and sometimes to leeward (as in fig. 1.) of the third division *a b,* are to be formed on two parallels of one of the close-hauled lines in the wakes of their respective headmost ships; while the third division *a b* is to be ranged ahead or astern of the others on the other close-hauled line, steering chequerwise the same course as the other divisions.

Plate DLXIX. fig. 1. and 2.

When *a b* is to windward of *c d* and *e f* (fig. 1.), De Grenier calls that the *windward primitive order of sailing,* and when to leeward (fig. 2.), the fleet is said to be in the *leeward primitive order of sailing.* These are the two principal positions in almost every case, and with very little variety, may become the order of battle, of chasing, &c.

His third order is illustrated by fig. 3. where the divisions *a b* and *e f,* are supposed at the distance of about six leagues from each other; *c d* and *e f* resting on the extremities of the base of a triangle STV, while the centre ship of the division *a b* rests on its summit T; none of the divisions could be cut off by an enemy, however formidable, seen from its centre ship at the distance of six leagues. For if, on the proper signal, the division *a b* should steer from T toward X, on the course opposite

Fig. 3.

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opposite to the close-hauled line it steered before, and the two divisions *c d* and *e f* steer from V and S towards X likewise, it is plain that each of these divisions would have only three leagues to run to join the other two, while the enemy which was first perceived at the distance of six leagues, must run nine before he can come up with the nearest of these squadrons.

91 His order of battle. Plate DLXIX. figs. 4. and 5.

To form De Grenier's order of battle represented in fig. 4. and 5. it will be sufficient for the ships of the three divisions ranged in the windward primitive order of sailing (see N° 90.) to heave in stays all together, and get on the other tack on the opposite line of bearing (fig. 4.); or for the ships in the leeward primitive order at once to haul the wind on the same tack as they steer; and they will find themselves in order of battle, fig. 5. When the two columns *c d* and *e f*, are to leeward of the third division *a b*, ranged in order of battle, this is called the *natural order of battle*, and when *c d* and *e f* are to windward of *a b*, this is the *inverted order of battle*. The former of these is calculated for a fleet combating to leeward, and the latter for a fleet which must fight to windward.

Fig. 6.

To explain the advantages of these dispositions, let us suppose the line AB, CD, EF, fig. 6. to represent an enemy's fleet to windward in the usual order of battle, on the close-hauled line, and on the starboard tack, and let *a b* be one of the divisions of a fleet disposed according to the now natural order, on the starboard tack, while the line *c d*, *e f*, represent the other two divisions standing on chequerwise on the same tack, but formed on the opposite close-hauled line. When the enemy comes to attack this latter fleet on a supposition that it is inferior to their own, their divisions AB and EF, in order to attack the ships *a* or *b*, must bear away. Now, to prevent the attack, each of the divisions *c d*, *e f*, must make the following evolutions according to their respective situations, and the manœuvres of the enemy. 1. The ships of the division *a b* are to slacken as much as possible their headway, and form a very close line, till the enemy makes a movement to attack the headmost or sternmost ship of that division. 2. The ships of the division *c d* are to make sail till they come under the second or third ship of the rear of the line of battle *a b*, when they will take the same sail as the ships of that division, to preserve that position until the hostile ships make their evolution to attack the rear ships of that division. In this situation the ships of the division *c d* will be able to observe the manœuvres of the enemy, in order to change tack, and form themselves in order of battle on the opposite board as soon as the hostile ships shall have run over a certain space; because the ships of the division *c d*, steering afterwards close hauled in the wake of the sternmost ship of the division *a b*, will be able to cover the rear ships of that division, and get the weather-gage of the hostile divisions which are bearing away; rake their ships; run along side of them; double their rear-guard, and put it between two fires, if those hostile ships are following in the wake of each other; divide it, if they bear away chequerwise; or gain to windward, and put between two fires the enemy's division CD, while engaged with the division *a b*. 3. The division *e f* may abandon their post, and run chequerwise under a press of sail as soon as the enemy falls a-head of *a b*; that if the enemy's division AB attempts to fall on *e f*, or on the van of *a b*, they may, by going about, steer in order of battle close hauled on the opposite line, and cover the ship *a*, double the hostile division CD a-head, or divide AB which is running chequerwise on the opposite tack.

Fig. 7.

Fig. 7. marks another method of manœuvring by the divisions *c d*, *e f*, when the enemy's ships are arranged in a single line not well formed.

92 De Grenier's method of arranging the admiral's ship, frigates and transports. Figs. 8. and 9.

Figs. 8. and 9. illustrate De Grenier's method of placing the admiral's ship, and the frigates and transports attached to a fleet. A, fig. 8. is the admiral placed a-head of the fleet, at a short distance from the headmost of the second division, and in the same direction of the wind as the headmost ship of the first division; *f f* are two frigates observing the same rule and position with respect to the van ship of the third, and rear of the first division. When the fleet is in order of battle, as in fig. 9. the admiral's ship A is in the centre of the lozenge, and two of the frigates, *f f*, on the fourth side of the lozenge. The transports and store-ships, when the fleet is in order of sailing or convoy, occupy the space circumscribed by the lozenge, but in order of battle they are disposed in a line opposite to that of the enemy.

We cannot enter on a more minute or satisfactory account of this system; for a full exposition of which we must refer to the original work entitled *L'Art de Guerre en Mer, ou Tactique Navale*, &c. par M. le Viscompte de Grenier, or the extracts from it contained in the *Elements and Practice of Rigging and Seamanship.*

93 Mr Clerk's tactics.

We must now turn our attention to the improvements in tactics suggested by our countryman Mr Clerk;—improvements which have received the approbation of several distinguished officers of the British navy, and to hints derived from which we are in a great measure indebted for some of the most signal victories which have heaped additional honour on the naval power of Britain.

94 Mr Clerk's objections to the usual method of attack.

Before entering on an explanation of Mr Clerk's tactics, we must briefly state his objections to the usual method of bringing ships to action, by the weather ship or fleet steering directly down upon the enemy. By doing this, the enemy to leeward often has an opportunity of completely disabling the ships making the attack, as the former can use all their guns on one side, while the latter can only use their bow chases. Suppose B, fig. 10. Plate DLXIX. to represent a ship of 80 guns to windward, in sight of an enemy's ship of equal force F, to leeward. Now, if B bears down directly upon F, the latter, by lying to, as in fig. 11. will present a broadside of 40 guns, all bearing for a considerable time on B, while the latter coming down headwise, can only bring the two light guns of her forecastle to bear on F, not to mention that F, by lying broadside to, will have her masts and rigging little exposed to the enemy's shot, while B standing head on, is exposed to be raked by every shot from F, and in particular her rigging is in the utmost danger.

Plate DLXIX. figs. 10. and 11.

95 His new method. Figs. 12. and 13.

Instead of this objectionable mode of attack, Mr Clerk proposes that B having the wind, should run down astern as in the dotted line at fig. 12. till she gets into the course of F, near her wake, or in such a position as will bring her parallel to F's course, and within a proper distance, when she can run up close along side of F, and engage on equal terms; or, that she should shoot a-head, then veer, and run down on the weather bow of F, as in fig. 13. till she can force the chase to bear

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bear away to leeward, keeping close by her, on equal terms, taking care in both cases not to put it in the power of F to bring her broadside to bear on her without retaliation.

96 Effects of firing at the hull or rigging. Plate DLXIX. fig. 14.

Fig. 14. is employed by Mr Clerk to illustrate the different procedure of a French and British man of war in firing, the former at the rigging, and the latter at the hull of the enemy, with their effects. Let F represent a large ship desirous of avoiding a close engagement, but lying to, to receive with advantage an enemy's ship B, of equal force. Suppose that F, by firing at the rigging of B, may have carried away some of the principal stays, several of the windward shrouds, a fore-topmast, or other rigging of less consequence, without having wounded a single man; and suppose a second ship consort to F, receiving an enemy's ship like B, but firing only at her hull, so as to kill 30 or 40 men, without damaging her rigging. Now, when F and her consort wish to avoid a close engagement, it is evident that that ship B, which has lost part of her rigging, is much more disabled from coming to close action than her consort whose rigging is entire, though she may have lost a great number of her men.

97 One ship of a line of battle cannot be exposed to the fire of many hostile ships at once. Fig. 15.

By the scheme at fig. 15. it is intended to illustrate the impossibility of one ship being exposed to the fire of many ships at one time. Let I, H, F, H, I, represent five ships in line of battle a-head, about a cable's length, or 240 yards asunder, and suppose the length of each ship to be 40 yards, so that the whole space between the head of one ship and the head of that next adjacent equals 280 yards. Let the perpendicular line FK, extending from the beam of F six cables lengths or 1440 yards, be divided into six equal parts. It is evident that any ship stationed at E in the line FK, 720 yards distant, cannot long be exposed to the fire of more than the centre ship F of this squadron. For if we suppose that H and K a-head and a-stern of F, can bring their broadsides to bear on E; by putting themselves in positions for that purpose, they will not only disorder their own line, but one will leave her head and the other her stern exposed to a raking fire from the opposite ships BB in the enemy's line. If B can suffer little from the two ships H, H, at the distance of 720 yards, it is evident that she will suffer still less from these ships as she approaches nearer the enemy's line. Again, if instead of a cable's length asunder, we suppose the ships I, F, I, two cables length asunder, to bear on the ship B. It is evident from the figure that in this case B will not be more exposed to the fire of I and I at the distance of 1440 yards than she was to that of H and H at half that distance; and so in similar cases.

98 Principles on which the bringing of ships to action is founded. Fig. 17.

In explaining the principles on which we are to judge of the advantages or defects of different modes of bringing ships to action, Mr Clerk supposes a fleet of 10, 20, or more ships of 80 guns each, drawn up in line of battle to leeward, as at F, fig. 16. and lying to with an intention to avoid an action; while another fleet, as B, of equal number and force, also drawn up in line of battle, three or four miles to windward, wishes to make an attack, and come to close quarters on equal terms. The fleets being thus disposed, should the fleet at B attempt running down to attack the fleet at F, each ship standing head on to the opposite ship in the leeward line, it is to be expected, from what we have already stated, that the attacking ships will be disabled, at least in their rigging, before they can come to close action; but suppose that the commander of the weather fleet, though his ships have been disabled in their rigging during their course *aaa* to leeward, fig. 17. has made them bring to at a great distance, but sufficiently near to injure F. This latter fleet, which has been endeavouring to avoid an action, will now bear away with little injury to a new station, as G, and there remain out of the reach of B's shot, and this fleet must repair its rigging before it can make another attack.

Fig. 17.

Again, suppose that the fleet B, instead of standing head on, were to run down in an angular course, as at fig. 18. It is plain that if any ship in this angular line should be crippled, her defect in sailing will occasion a confusion of several of the other ships in that line. It may be said that the stoppage of one ship a-head will not necessarily produce a stoppage of every ship a-stern of her, because they may run to leeward of the disabled ship; but we must observe that by this time the ships a-head in the van A may be engaged, and consequently not having much head way, are nearly stationary, so that each ship a-stern, in attempting to bear down as at D, D, must be confined to a certain course, and must run the risk of being raked in coming down before the wind, and consequently of being disabled before coming up with the enemy. Fig. 18.

Thirdly, the van of the fleet B having attained their station at A, a-breast of the van of F, fig. 19. and having begun the action, the van ships of F, with a view to retreat, may throw in a broadside on the van of B, and then bear away in succession, as at H, followed by the rest of the fleet F, which, after exchanging broadsides with the van of B, may draw up in a new line two or three miles to leeward at I I, fig. 20. Fig. 19.

Suppose again, for further illustration, that B, fig. 1. Plate DLXX. represents a fleet putting before the wind, each ship intending, when brought to at a determined distance at A, to take up her particular antagonists in the line of the enemy F to leeward; and let F be supposed at rest, without any motion a-head. It is easy to conceive that while the alternate ships of F's line, under cover of the smoke, withdraw from battle to GGG, the intermediate ships left behind them in the line will be sufficient to amuse even the whole of B's fleet, till the ships G shall form a new line HH as a support from the leeward. In such case B, after being disabled, and not having foreseen the manœuvre, will neither be able to prevent the intermediate ships with which he is engaged from bearing away to join their friends, nor, were he able, would it be advisable to follow them, for the same manœuvre with equal success can again and again be repeated. Plate DLXX. fig. 1.

To explain the relative motion of these two fleets, let F, fig. 2. represent a fleet of 12 ships in line of battle, a cable's length asunder, and suppose the length of each ship from the end of the jib-boom to the stern to be 36⅔ fathoms. The whole fleet will occupy a space of two English miles; and if it be supposed to sail in the direction FG, at the rate of four knots an hour, it will in an hour have moved to G, four miles from its former position. Fig. 2.

Now, let there be an opposite fleet B, also 12 ships, situated four miles to windward, and let the point A be a quarter of a mile right to windward of the point G. Then, if B by bearing away in the direction BA, gain the

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the point A at the same time that the leeward fleet F has arrived at G, B will have moved nearly at the rate of $5\frac{1}{7}$ miles an hour, and the angle contained between the direction of its line of bearing and its present course will be nearly four points.

Secondly, in fig. 3. if F, by carrying more sail, move at the rate of six miles an hour, from F to G, then B, with a more slanting course, will have more difficulty in keeping the line a-breast while coming down to the attack, owing to the additional obstruction which will attend each succeeding ship in such a slanting course. Again, if the leeward fleet shall lie up one point higher, as FG, fig. 4. the rears of the two fleets will be removed to a much greater distance, and the van A must be sooner up with the enemy's van, and of course so much farther from support, while F bringing up his ships in succession, may disable the van of A, and afterwards bear away at pleasure with little injury, as at H. Now B being supposed disabled, and having his rear D distracted, will be unable to prevent F from escaping.

From these considerations it appears that a fleet to windward, by extending its line of battle with a view to stop and attack the whole line of an enemy's fleet to leeward, must labour under considerable disadvantages, and will scarcely succeed in the attempt.

99 New mode of attack from the windward.

On these principles Mr Clerk explains the reason why, before the commencement of the present contest between Britain and France, the French fleets so repeatedly escaped from the British without any serious defeat or loss, viz. by avoiding a general engagement, and disabling the British van as it bore down to attack them. He therefore recommends a different mode of attack from the windward, which we shall proceed to illustrate by proper diagrams.

Fig. 5. Let F (fig. 5.) represent a fleet in line of battle, under easy sail, willing to avoid an action, but ready to receive an attack in the usual way, from another fleet B, three or four miles to windward, arranged in three columns. How shall B make the attack on F, so as, without aiming at the improbable advantage of taking or destroying the greater part of this fleet, they may secure three or four of the sternmost ships? Mr Clerk advises, that a sufficient strength be detached to secure these ships, while the admiral keeps aloof with the rest of his fleet, disposed as in the figure, ready to make the necessary observations and give the requisite support to the detached ships. If F continues to avoid an action by standing on in line, the detachment, coming into the position BA, will secure the three ships at I; and if the headmost ships of F were to tack, and be followed by the rest in succession as at fig. 6. not only the three ships at I will be left at the mercy of the ships detached from B, but two more, as G, will be exposed to an attack from another squadron of B at C. If all the ships of F tack together, as in fig. 7. the delay, and probably the confusion, consequent on this manœuvre, will still more endanger the sternmost ships, or will bring on a general and close action. Again, if F attempts to haul off, beginning with his sternmost ship G, and then runs to leeward, as at fig. 8. he will expose his ships to a raking fire from B, and still endanger his sternmost ships by getting too far to leeward for their support; or if the headmost ships at H, fig. 9. veer first, to be followed by the rest astern, the danger would be still greater. Thus it appears that in every assignable case, a fleet to leeward, avoiding an attack from an equal or superior windward, as here advised, by preserving the line, will risk the loss of three or more of their sternmost ships.

Fig. 6. Fig. 7. Fig. 8. and 9.

Fig. 10. 11. 12. Now, let us suppose that F, while standing on a line on the larboard tack, when threatened with an attack on his rear from B, veers and passes on opposite tacks to leeward (see fig. 10.). The consequence of this will be, that his headmost ships will be forced to leeward by B, and compelled to engage under disadvantageous circumstances, and the disadvantage to F will be much the same, whether he again veers and resumes his former position, as at G, fig. 11. or stands on before the wind, as at P, fig. 12.

Fig. 13. We have hitherto supposed that the wind has been fixed in one point; but let us suppose it to shift, and let us inquire what will be the effect of such a circumstance on the two lines F and B. While the fleets are in the former position, F in line, and B in four divisions, B, B, B, A, steering E, with the wind at N, fig. 13. let the wind shift to the west. The only consequence of this will be, that F will be thrown still farther to leeward, to its greater disadvantage. But let the wind shift to E, so as to be a-head, as in figs. 14. and 15. Still if the admiral of B manages properly, and carefully watches the motions of F, this change will produce no advantage to the latter. For B has nothing to do but veer as the wind comes round, so as to bring his ships to windward of the three sternmost ships of F, and to leeward of the rest of his line, so as to cut off the three sternmost ships. Figs. 14. and 15.

If the wind should be supposed to veer from point to point all round the compass, so that the fleet F, maintaining the weather-gage of B, shall make a circuit round B to leeward; still if B act cautiously, F will lose the three threatened ships.

Fig. 16. Lastly, suppose the wind should instantly shift to a point opposite to what it was at the commencement of the attack, as from N. to S. Before it can be ascertained whether such a change will be to the advantage or disadvantage of F, the relative situations of the two fleets must be considered. Suppose that the van and centre be separated at some distance from his rear, and that in consequence this fleet shall have taken such a position as is shown at fig. 16. Though in this case he will have got to windward, his three ships can never be regained or preserved from the attack of B. The most favourable situation for F would be when the fleets were in the position denoted by fig. 13. as then he could not only support his three ships with advantage, but even threaten, and cut off a part of B's detachment. In attempting this, however, he incurs the risk of coming to a close engagement, which we have supposed him to be sedulously avoiding. Fig. 16.

100 From the leeward.

Besides this method of attack from the windward by detachments from the main fleet, Mr Clerk shows how a successful attack may be made by a fleet *to leeward*, by its breaking the enemy's line, and this either near the rear, near the centre, or not far from the van, of which cases the two former will be most likely to prove successful. The enemy's line can only be cut when the two hostile fleets veer on opposite tacks. The most simple method of effecting this is for the van ship of the attacking squadron, instead of ranging parallel to that of the enemy, and to leeward of him, to pass through the

Naval Tactics.

the first interval that offers, followed by the rest of the line, which is thus led across that of the enemy. In consequence of this manœuvre, the van of the leeward fleet will be to windward of the enemy's rear, and thus the attacking squadron will have its line entire, while that of its adversary is divided. Again, the ships of the rear division, having their progress obstructed, will probably crowd on each other, get into confusion, and be driven to leeward. We cannot detail the different cases mentioned by Mr Clerk; but for these and many other valuable suggestions on the subject of naval tactics, we must refer to his useful and ingenious Essay *.

* See *Clerk's Essay on Naval Tactics*, second Edition.

The above is a very faint and meagre outline of Mr Clerk's tactics, but it is all which our limits enable us to give. It will afford general readers some idea of the nature of the proposed improvements, and professional men will naturally consult the original *essay*.

On these or similar principles is founded the method of *breaking through the enemy's line*, and thus cutting off a part of his fleet, so successfully adopted by the British admirals in the great naval actions that have distinguished the late and present wars with France. We cannot better illustrate the principles above laid down, than by giving a short detail of the last of these memorable engagements, the BATTLE OF TRAFALGAR. With this we shall conclude our sketch of *naval tactics*, and our practical observations on the art of WAR.

101 Battle of Trafalgar, October 21st, 1805.

After having been long blocked up in the harbour of Cadiz, the combined French and Spanish fleet effected their escape, while the British fleet, under the command of Lord Nelson, was at a considerable distance. On the 19th of October 1805, the ships which had been left to watch the motions of the enemy, communicated to the commander in chief the agreeable intelligence, that the combined fleet had put to sea, and was sailing with light winds in a westerly direction. Lord Nelson concluding that their destination must be the Mediterranean, immediately made all sail with his ships for the entrance of the straits. Here he was informed by Captain Blackwood, that the enemy had not yet passed the straits.

On the 21st of October, at daylight, Cape Trafalgar bearing east by south about seven leagues distant, the combined fleet was discovered about six or seven miles to the eastward. The wind was about west, and very light. As Lord Nelson had long expected to fall in with the enemy's fleet, he had concerted with his officers the best and most expeditious measures for bringing them to a speedy and decisive action. As soon, therefore, as they hove in sight, he immediately made the signal for the British fleet to bear up in two columns, as they formed in order of sailing. The combined fleet was drawn up in line of battle, with their heads to the northward, and had formed the line with great closeness and correctness. It consisted of 33 ships of the line, 18 French, and 15 Spanish, under Admiral Villeneuve, as commander in chief, who occupied the centre in the Bucentaure, while the Spanish admiral, Gravina, led the rear in the Prince of Asturias. The British fleet consisted of 27 ships, including three sixty-fours. Lord Nelson headed the van in the Victory, having under him the Temeraire, Neptune, Conqueror, Leviathan, Ajax, Orion, Agamemnon, Minotaur, Spartiate, Britannia, Africa, with the Euryalus, Sirius, Phœbe, and Naiad frigates, Pickle schooner, and Entreprenante cutter; while the rear, consisting of the Royal Sovereign, Mars, Belleisle, Tonnant, Bellerophon, Colossus, Achille, Polyphemus, Revenge, Swiftsure, Defence, Thunderer, Defiance, Prince, and Dreadnought, was led by Vice-admiral Collingwood in the Royal Sovereign.

As the mode of attack adopted by the British was unusual, the combined fleet was obliged to draw up their line in a new manner. It formed a crescent, with its convexity to leeward, so that in leading down to their centre, the rear division of the British had both their van and rear abaft the beam. Before the action commenced, every alternate ship was about a cable's length to windward of her second ahead and astern, thus forming a kind of double line, and appearing, when on their beam, to leave a small interval between them without crowding their ships. The French and Spaniards were not formed in separate divisions, but intermixed without any apparent regard to order of national squadrons. As the British commander had previously communicated to his flag-officers and captains his preconcerted mode of attack, few signals were necessary, and none were made on approaching the enemy, except to direct close order as the lines bore down.

The action commenced at noon, by the leading ships of both columns breaking through the enemy's line; the Victory about the tenth ship from the van, and the Royal Sovereign about the twelfth from the rear; the succeeding ships breaking through in every part astern of their leaders, and engaging the enemy at the very muzzles of their guns. By this manœuvre the van of the enemy was unengaged, and thus the inferiority of the British, in point of number, was of less consequence, while the superior skill and bravery of British seamen soon acquired a decided advantage. The conflict was severe, as the enemy's ships were fought with a gallantry highly honourable to their commanders. The British attack, however, was irresistible. About three P. M. many of the enemy's ships had struck their colours, and their line had given way. Ten ships of the line, and the frigates, under Admiral Gravina, made their escape, and stood to leeward towards Cadiz. The five headmost ships of their van tacked, and standing to the southward, to windward of the British line, were brought to action, and the sternmost of them taken. Nineteen ships of the line, with three flag-officers, including the commander in chief, remained in the hands of the British. Never was there a victory more glorious or more decisive; never was the pre-eminence of the British flag more triumphantly conspicuous.

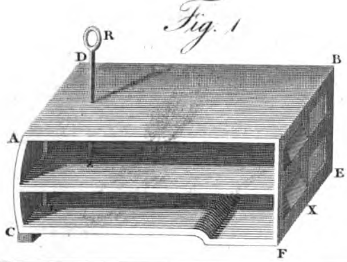
The events subsequent to this memorable battle, and the losses sustained on either side, having little connection with the subject of the present article, need not be here detailed. They are fresh in the memory of our readers, and Britain still laments the loss of her immortal Nelson *.

* See *Nelson*.

VENTILATOR

Plate DXLIV

Fig. 1



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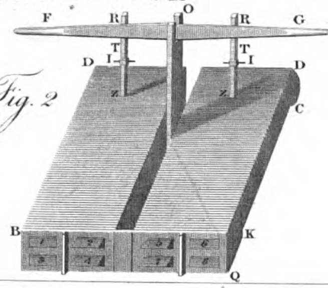
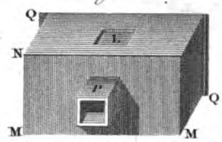
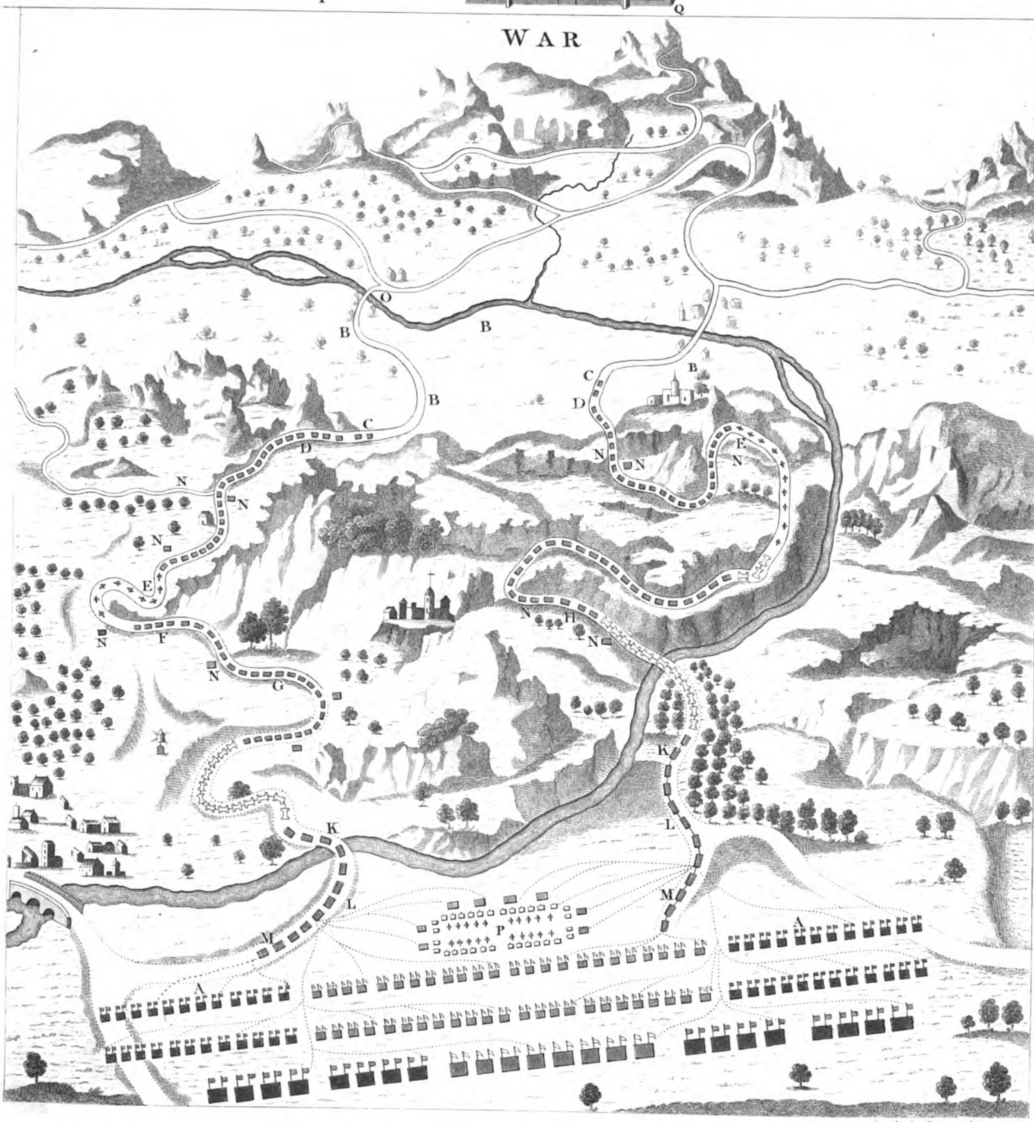


Fig. 3



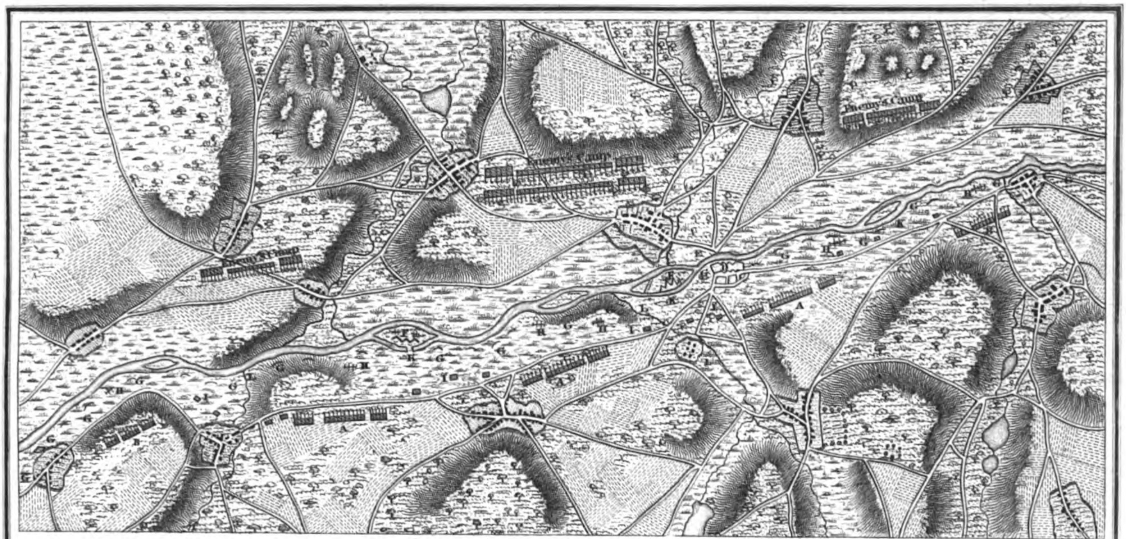
WAR



Smith Sc. Clements Inn, Strand.

PLAN OF THE POSITION OF AN ARMY FOR THE DEFENCE OF A RIVER.

I.

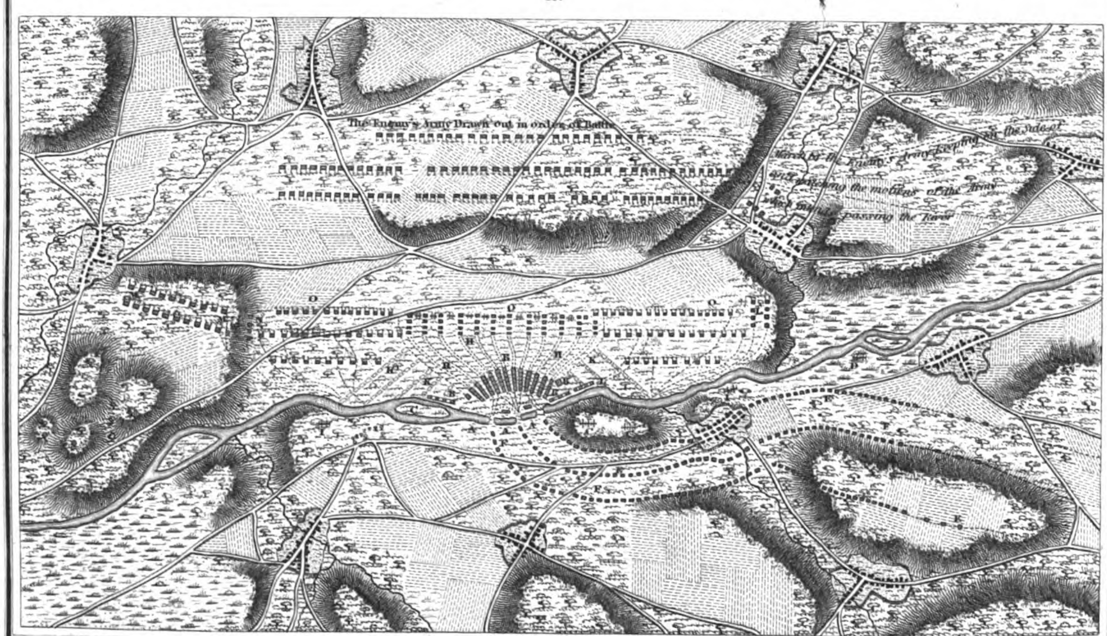


Scale of 1 League

100 400 1200 2400 T.

PLAN OF THE PASSAGE OF A RIVER

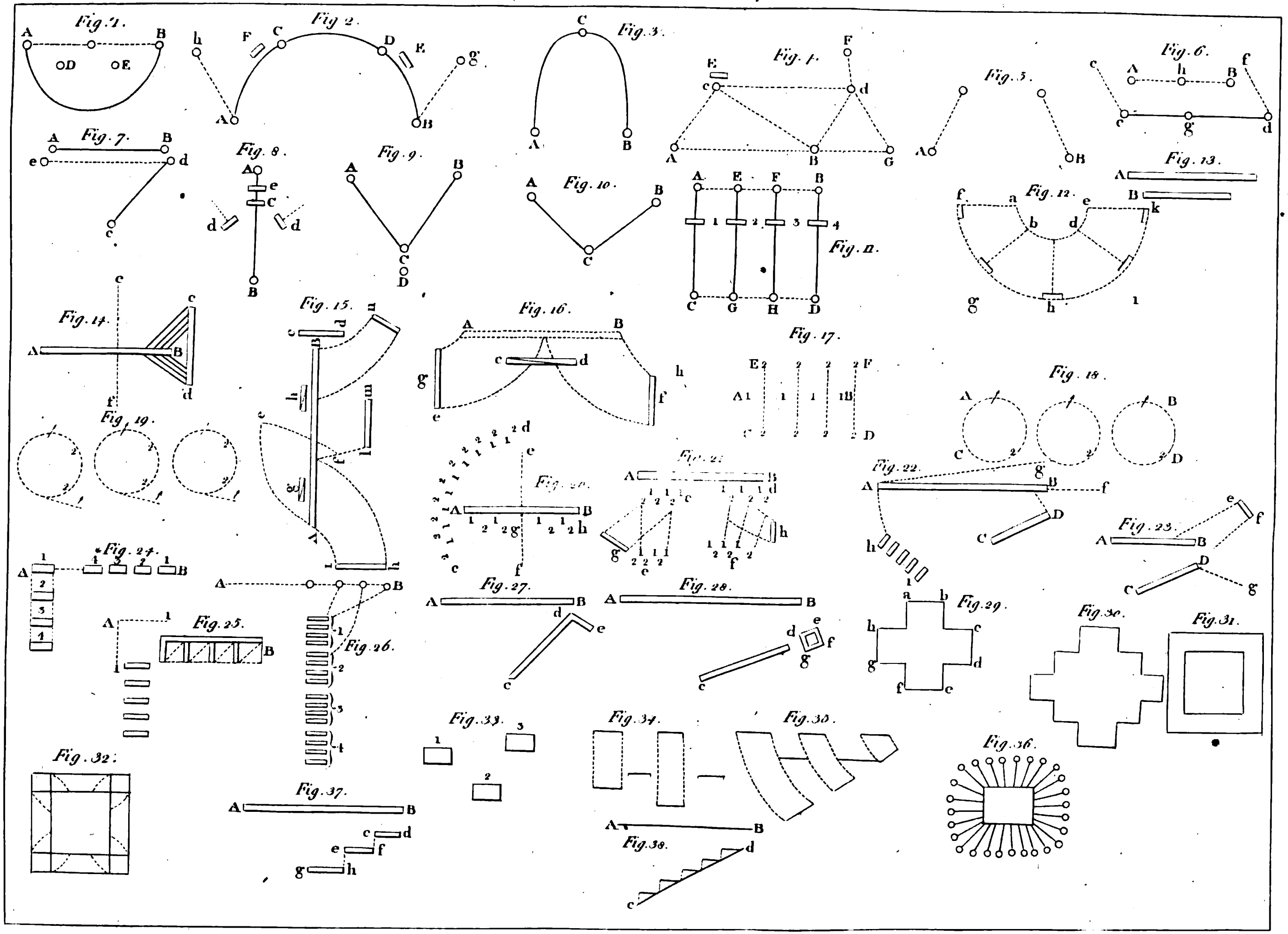
II.



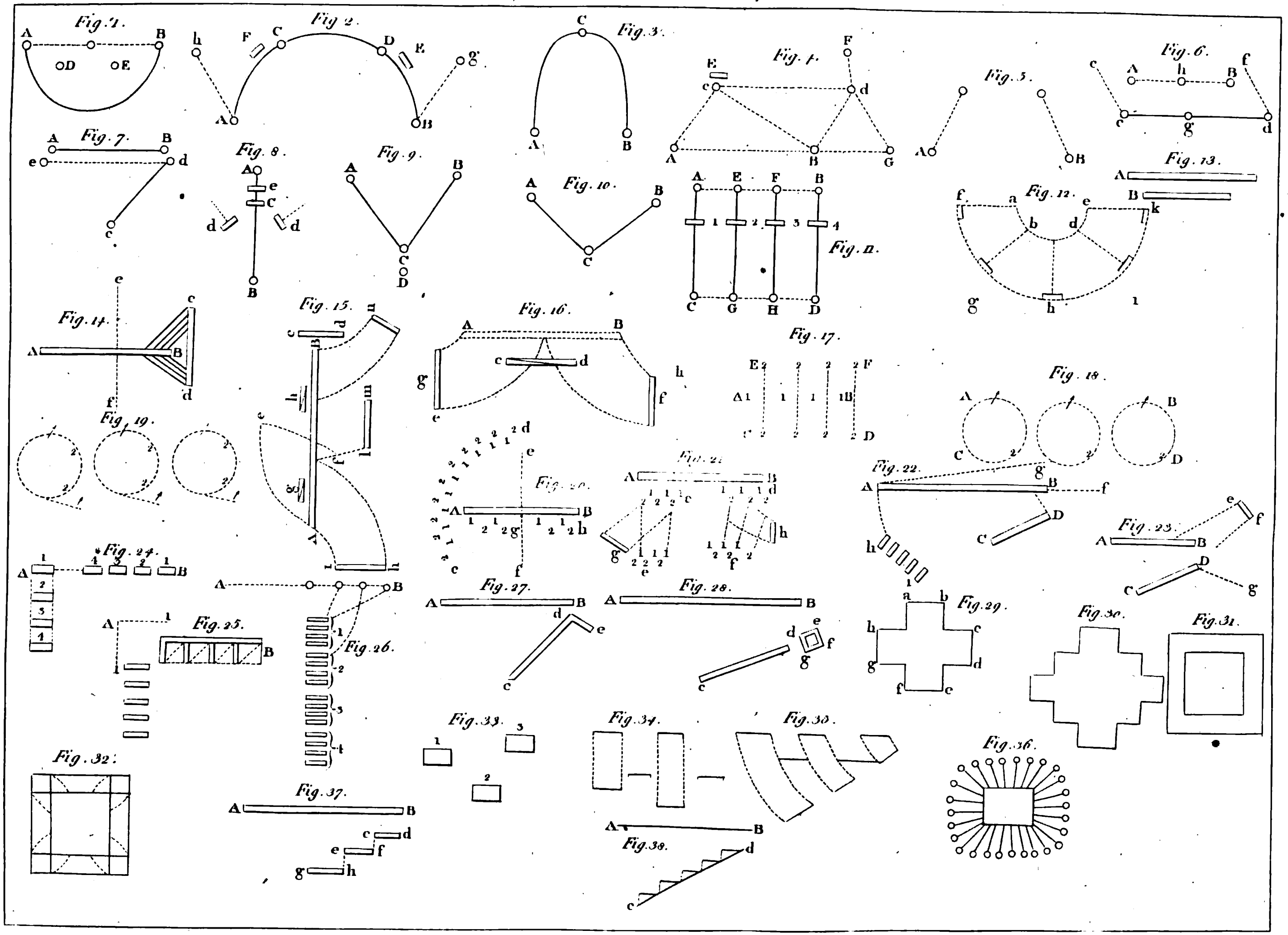
Engraved by W. & D. Lizars Edin.

Scale of ½ a League

30 300 600 1200 T



E. Mitchell sculp.

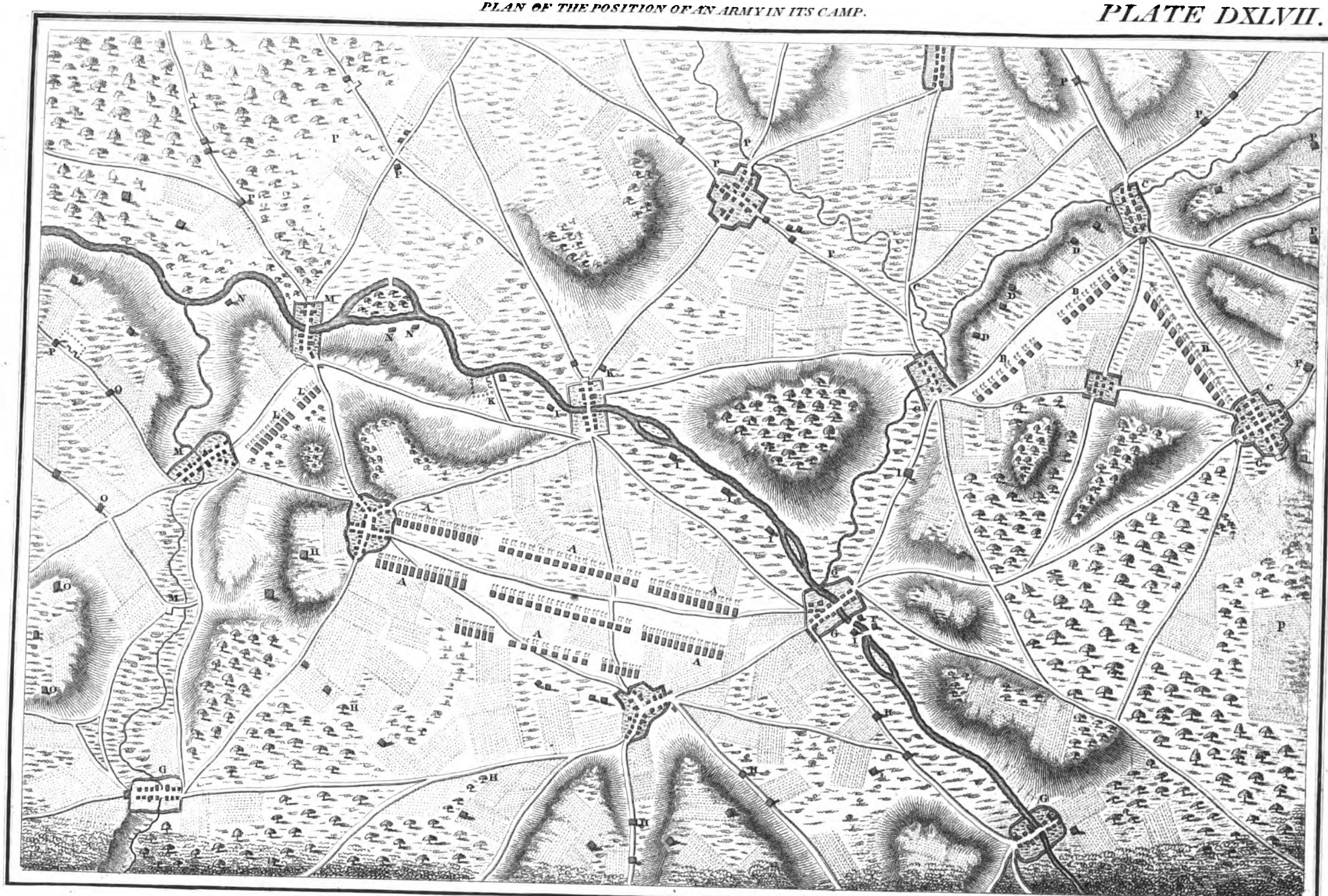


E. Mitchell sculp.

WAR.

PLAN OF THE POSITION OF AN ARMY IN ITS CAMP.

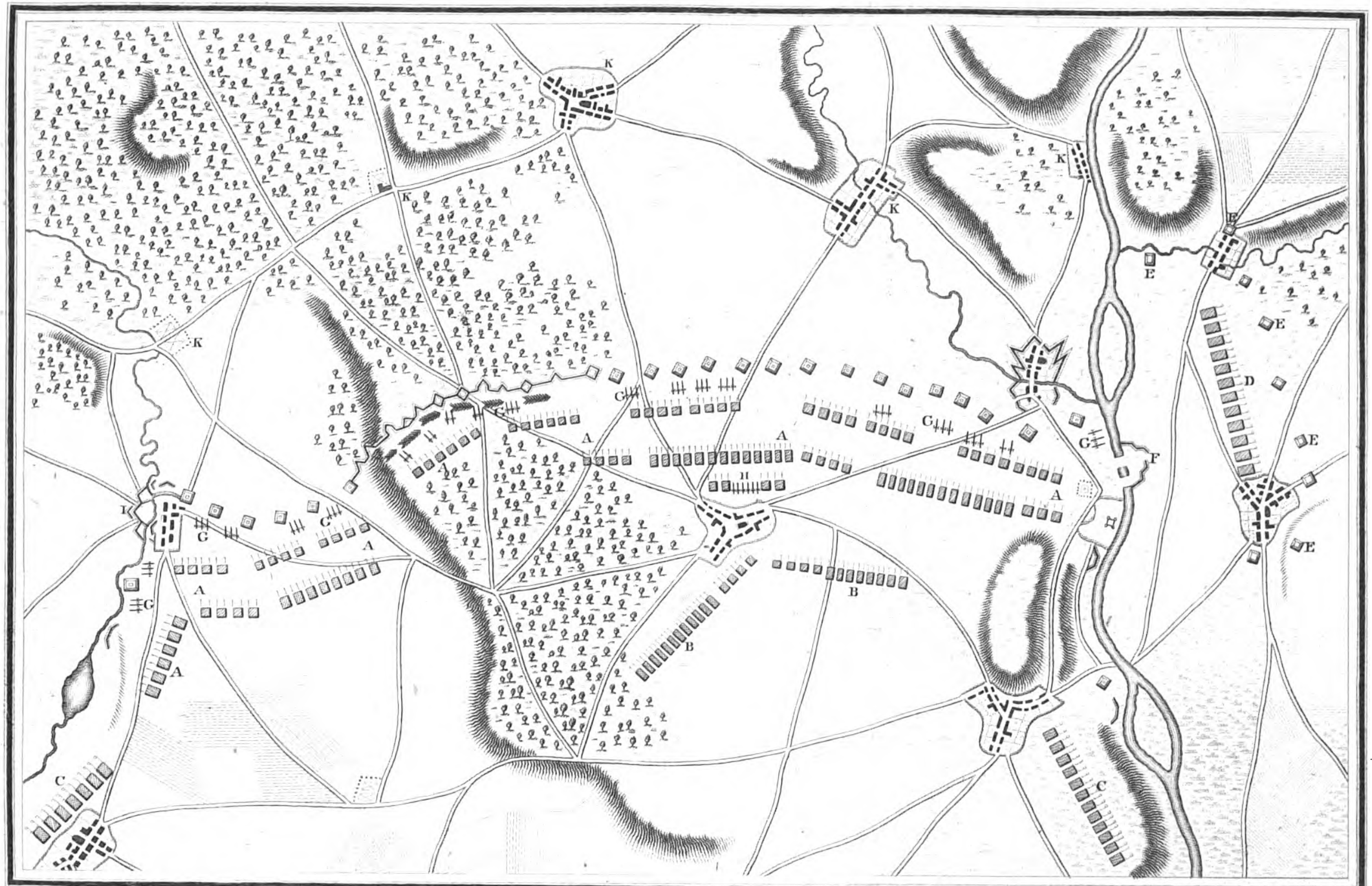
PLATE DXLVII.



Engraved by W. & D. Lizars Edin.

WAR.

PLAN OF AN INTRENCHED CAMP.

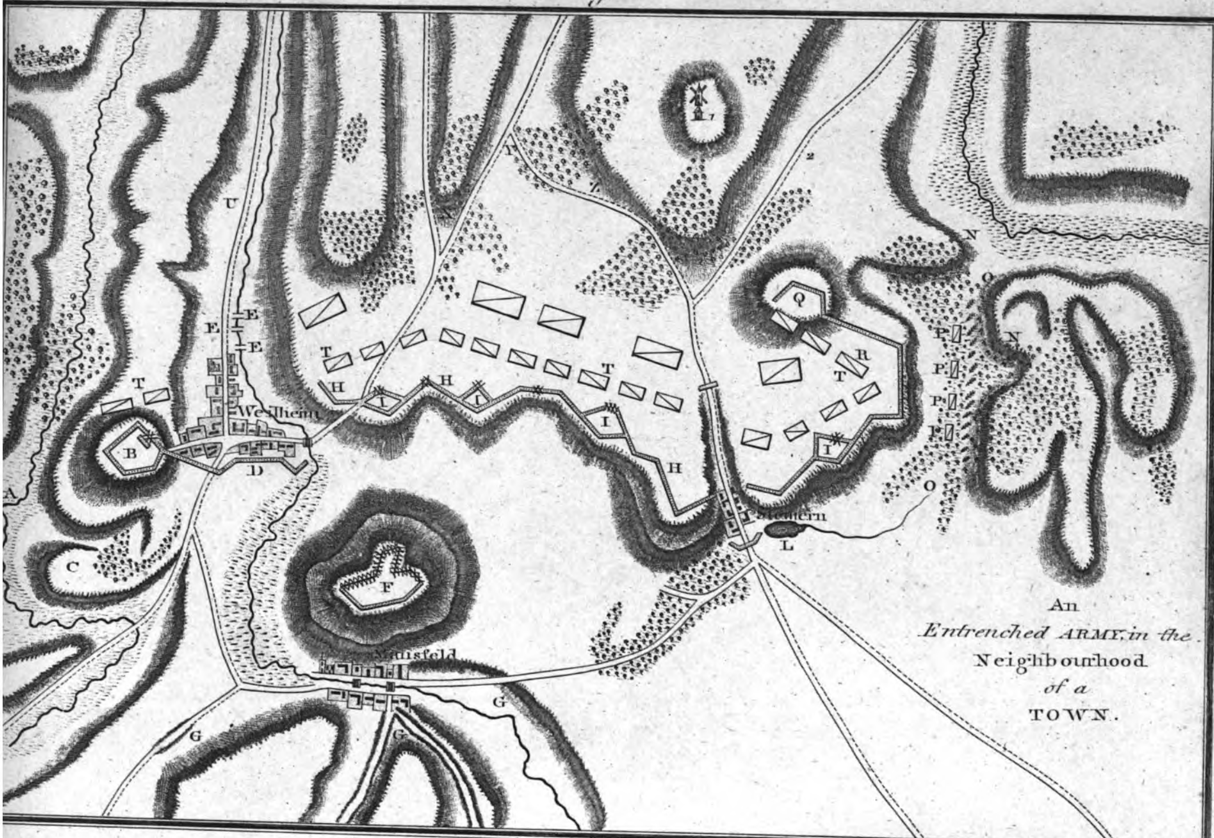


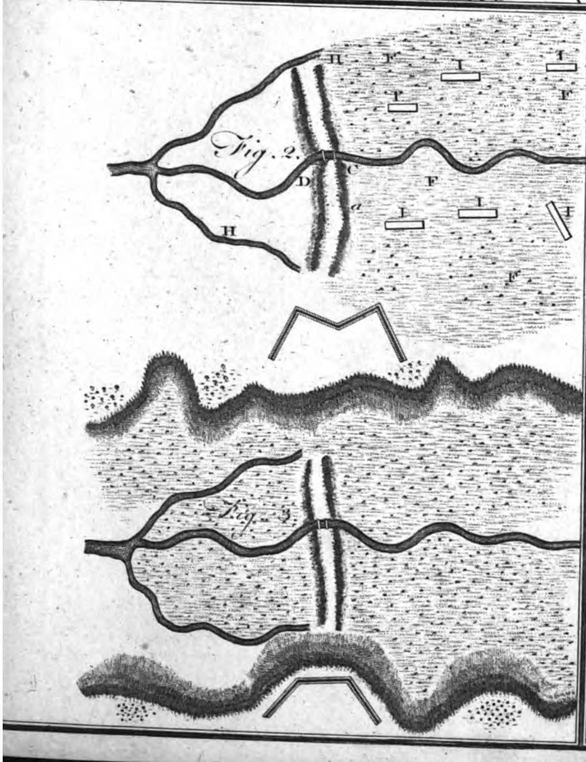
W. Archibald Sculp.t

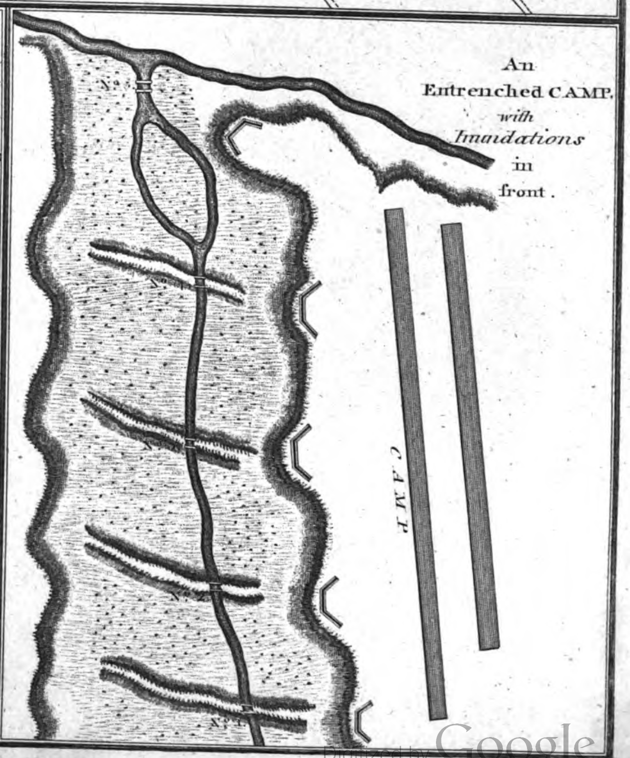
Scale of ½ a League.

50 200 400 600 1200 T.

Fig. 1.

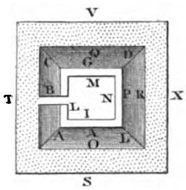






W. Train Sculp.

Fig. 1.



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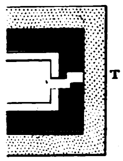

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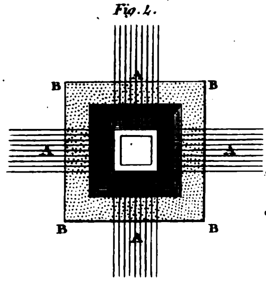

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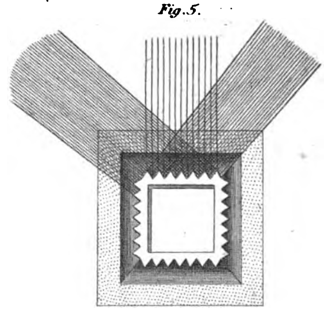


Fig. 6.

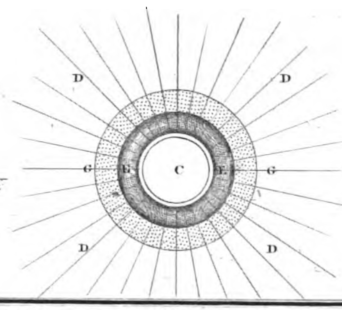


Fig. 3.

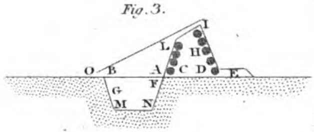


Fig. 7.

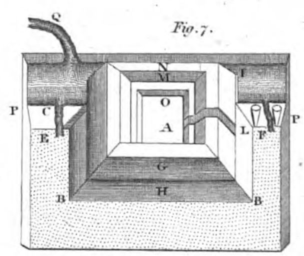
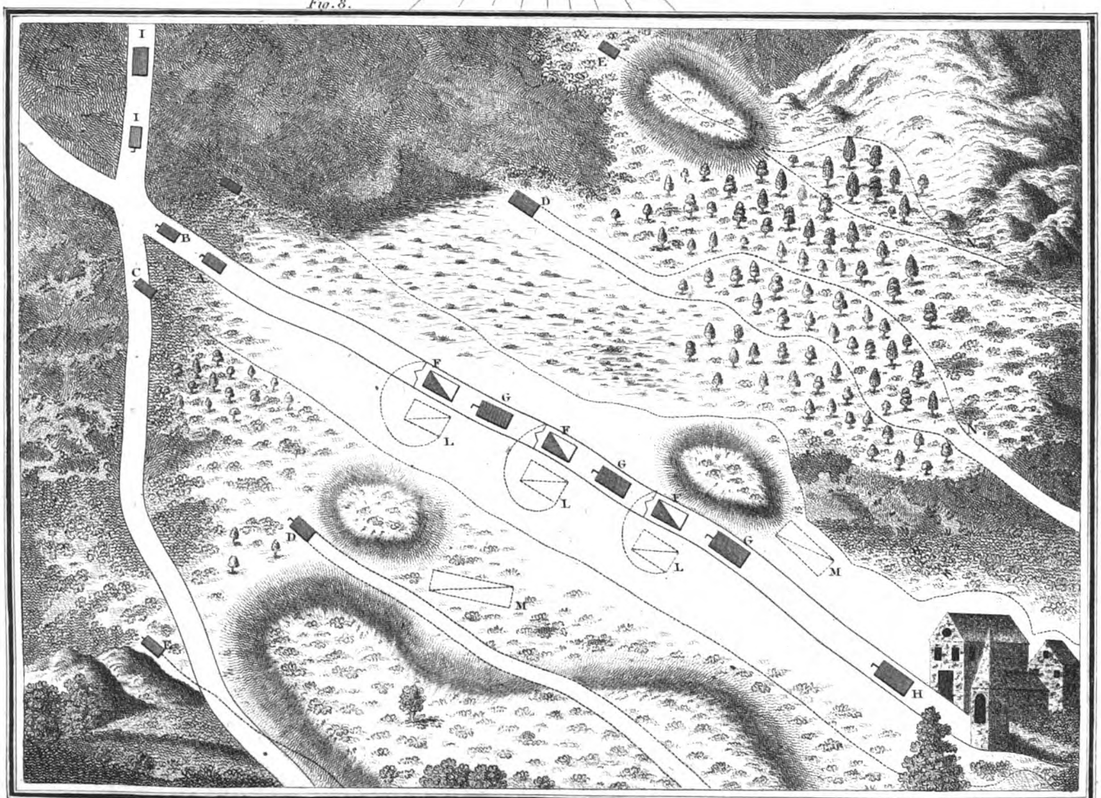


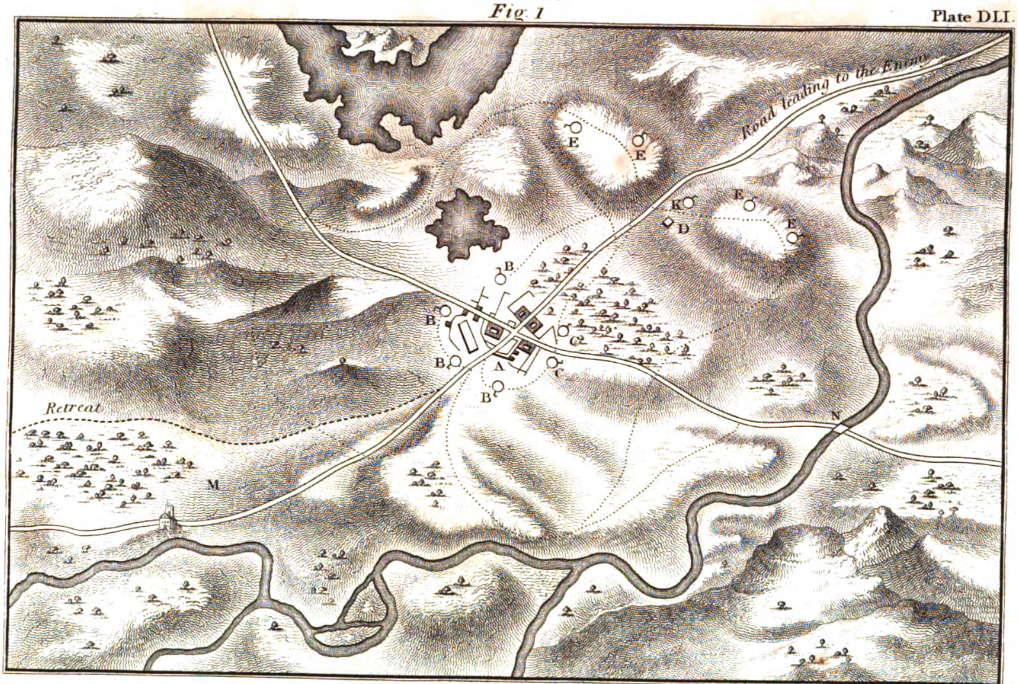
Fig. 8.



Eng.d by W. & D. Lizars Edin.r

WAR

Fig. 1



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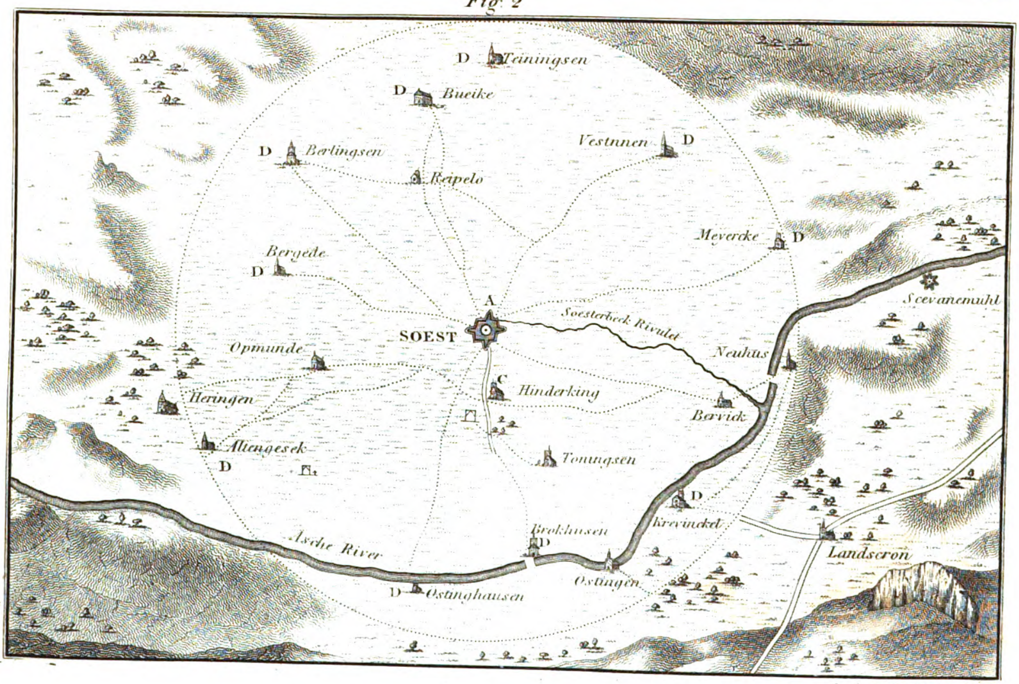

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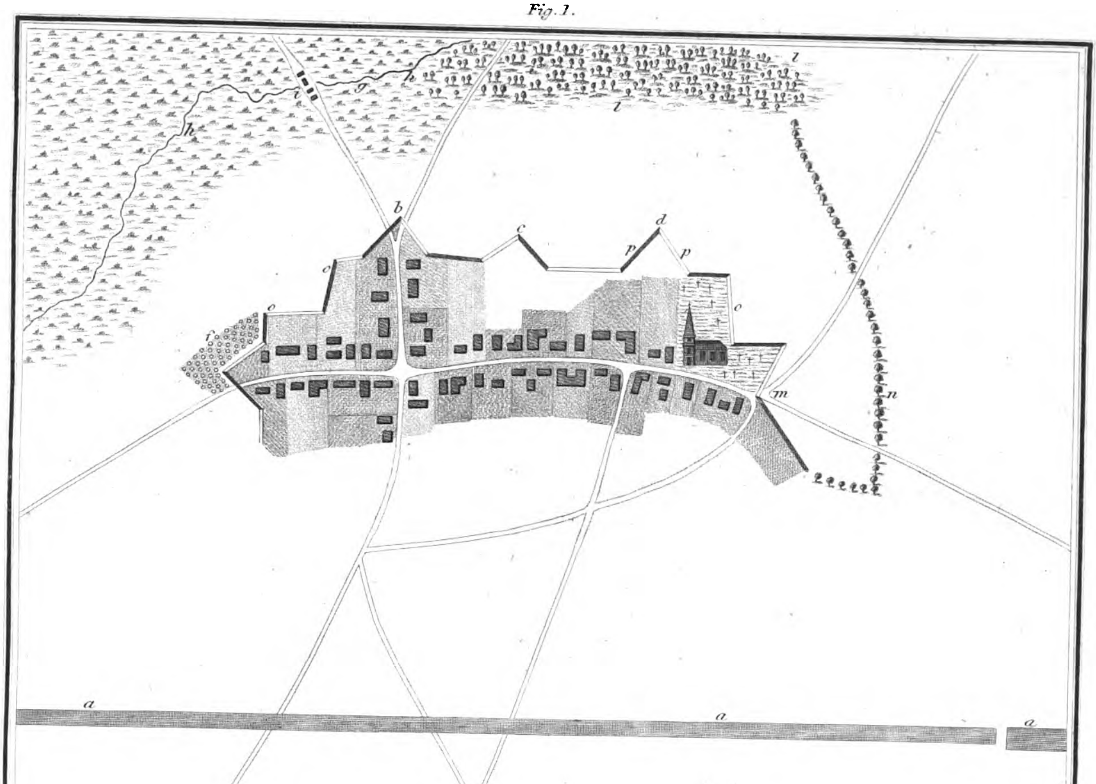
Fig. 1.



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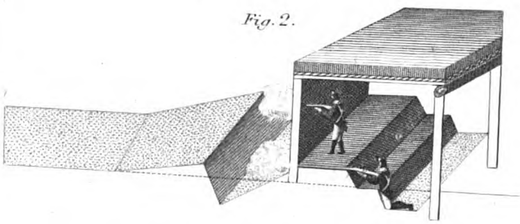


Fig. 3.

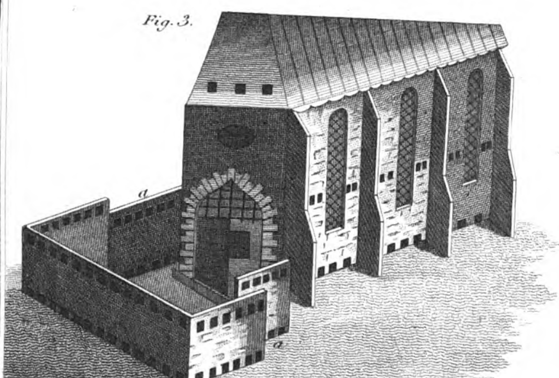
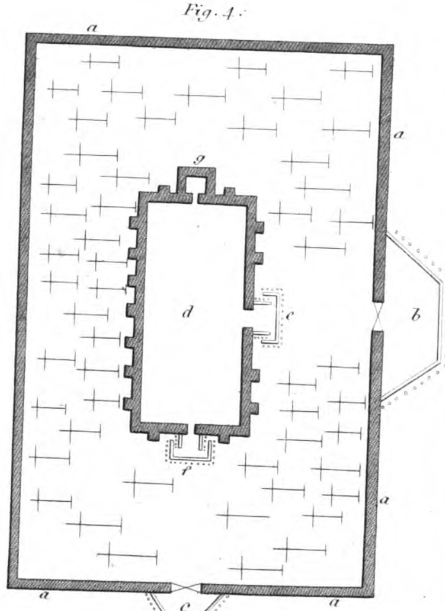
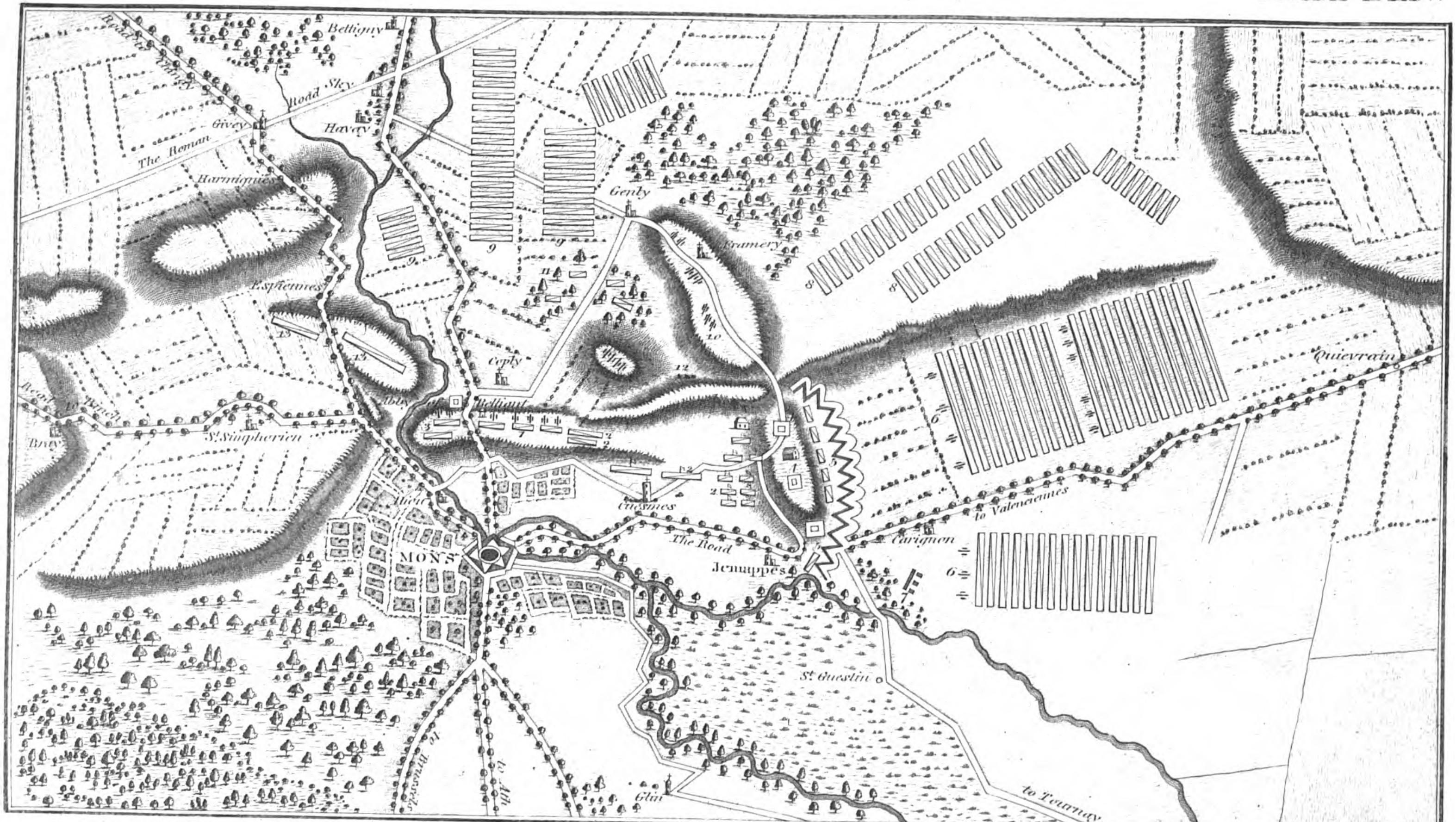


Fig. 4.



Wm Archibald Sculpt.



W. Train Sculp.t

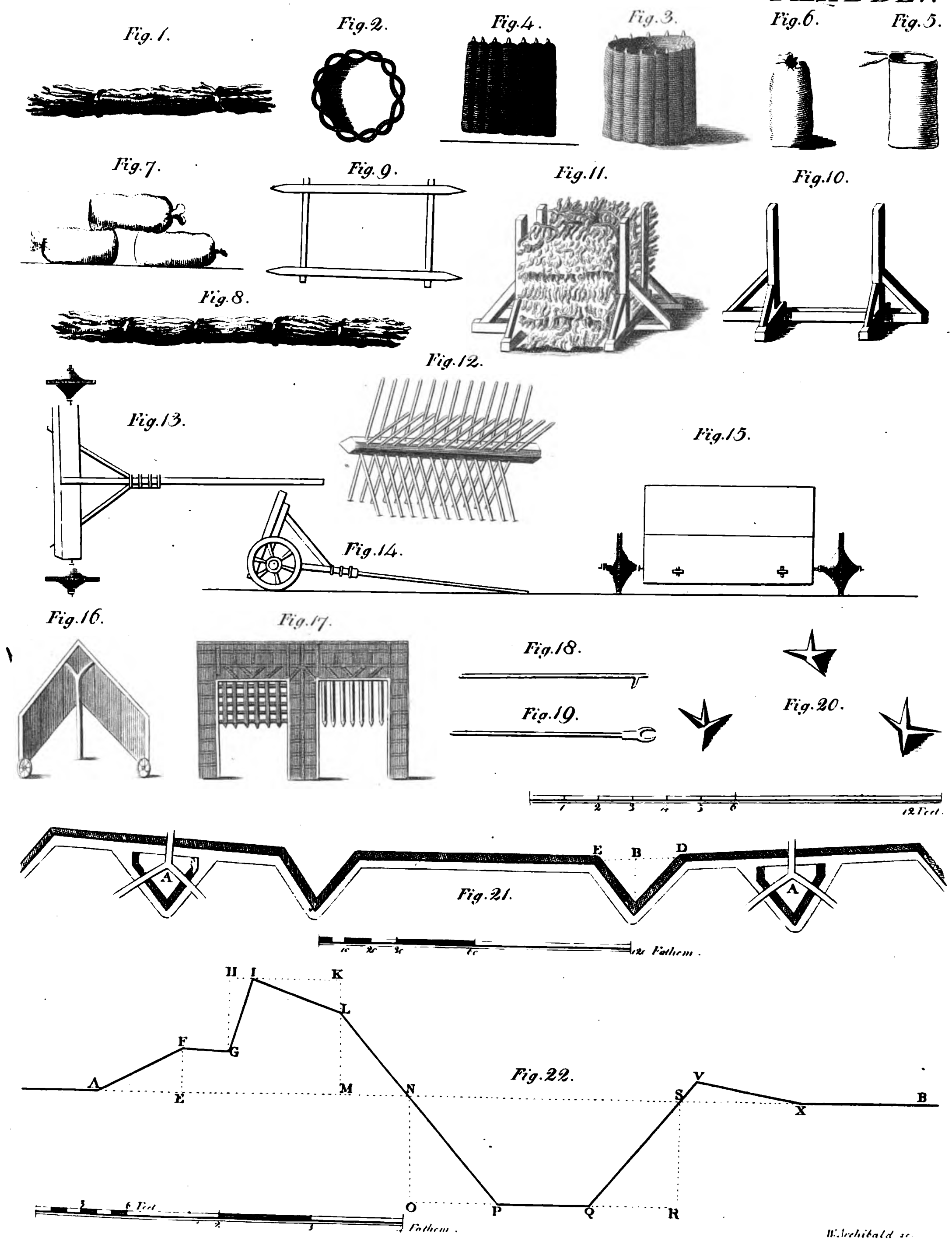


Fig. 1.
Fig. 2.
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Fig. 5.
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Fig. 11.
Fig. 10.
Fig. 8.
Fig. 12.
Fig. 13.
Fig. 15.
Fig. 14.
Fig. 16.
Fig. 17.
Fig. 18.
Fig. 19.
Fig. 20.
12 Feet.
E
B
D
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A
Fig. 21.
Fathom.
H
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K
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Fig. 22.
V
S
X
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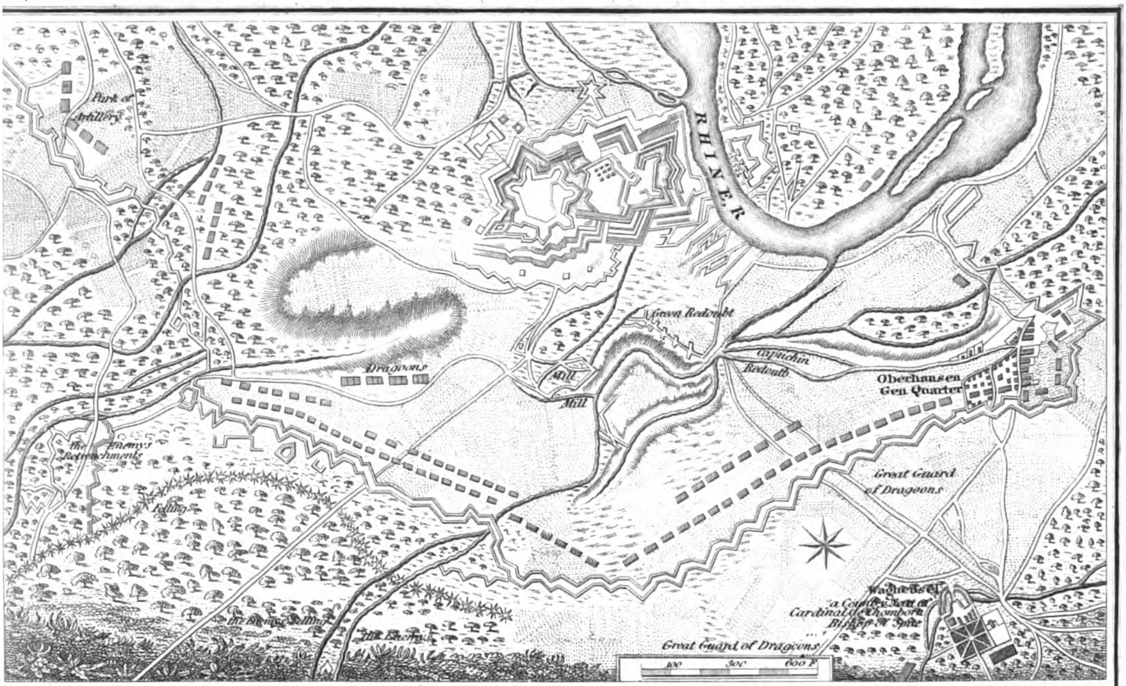
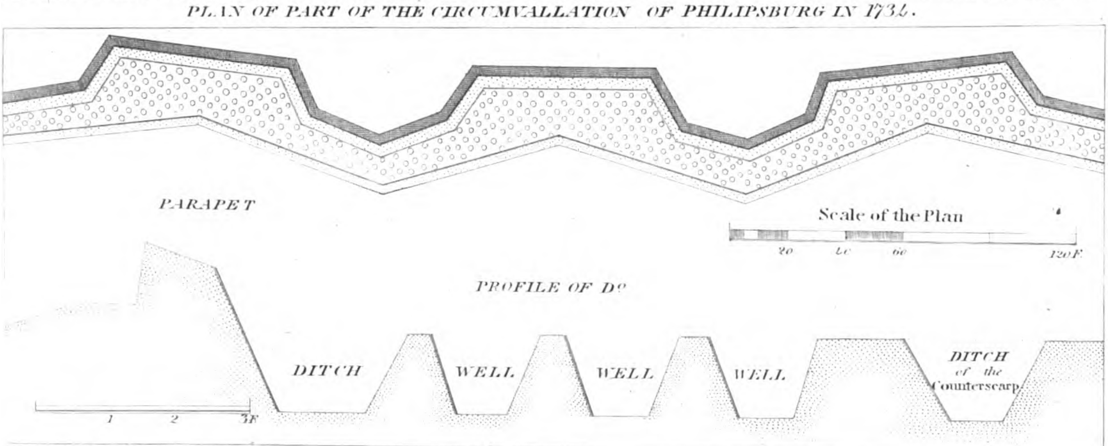
R
6 Feet
Fathom.
W. Archibald sc.

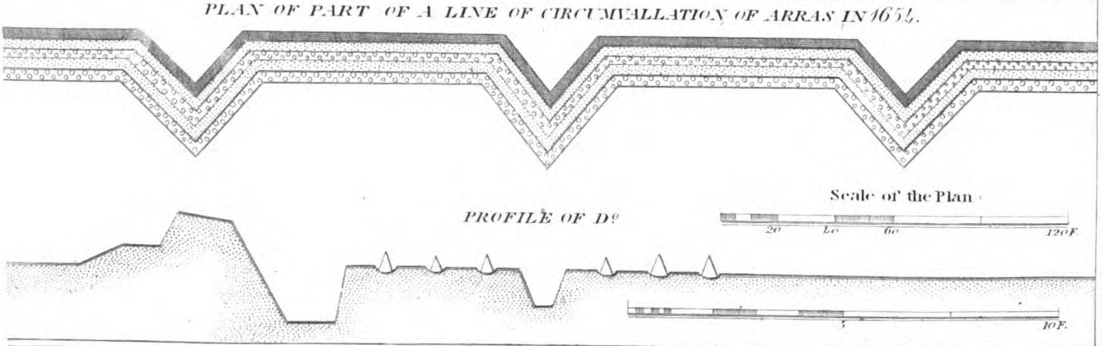
PLAN OF THE CIRCUMVALLATION AND ATTACKS OF PHILIPSBURG in 1734.



PLAN OF PART OF THE CIRCUMVALLATION OF PHILIPSBURG IN 1734.

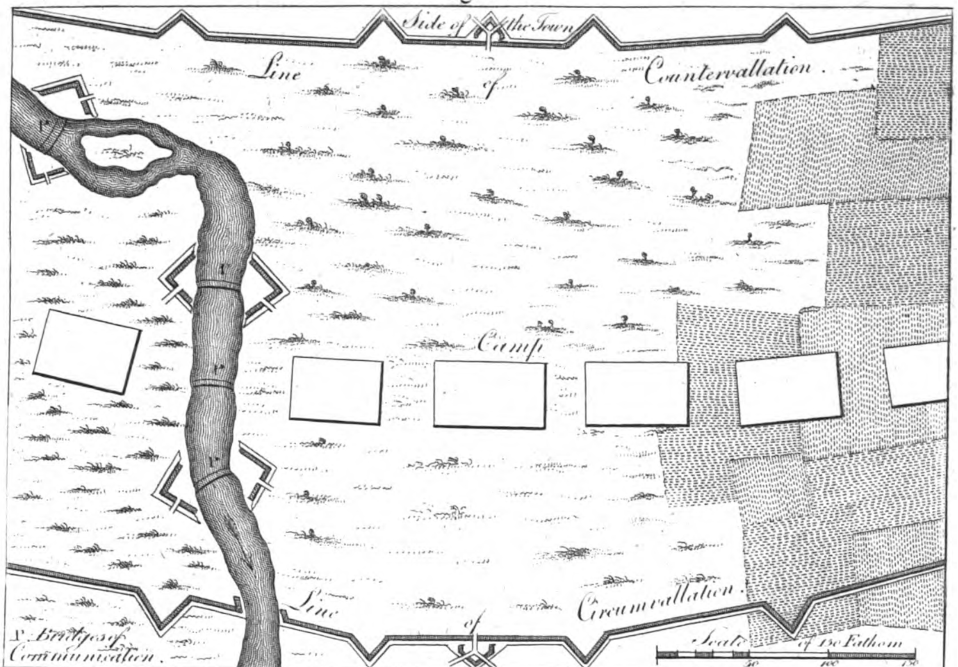


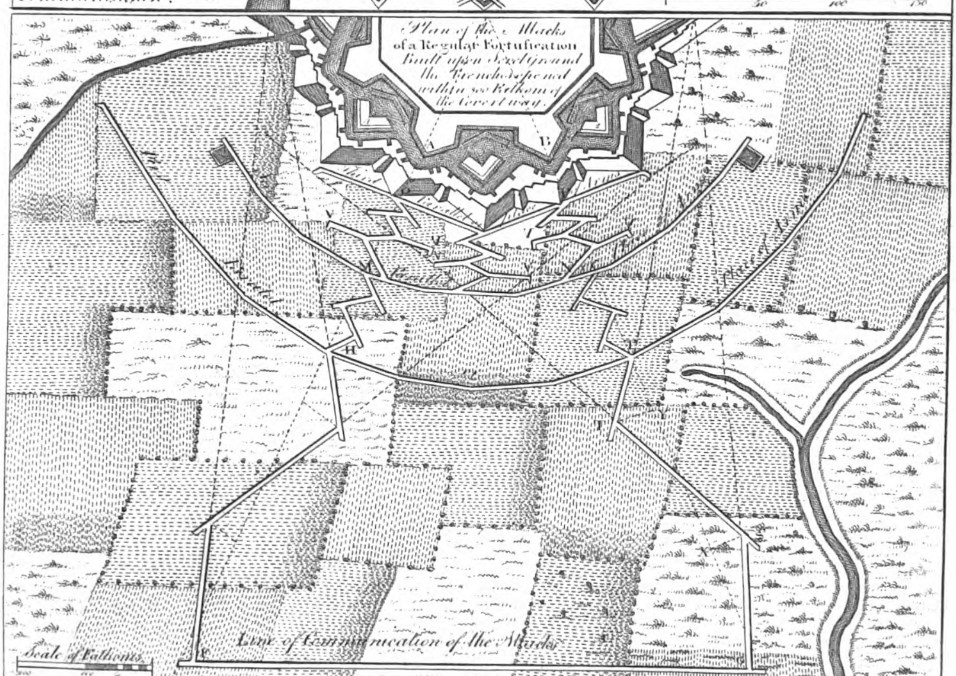
PLAN OF PART OF A LINE OF CIRCUMVALLATION OF ARRAS IN 1654.



Engraved by W. & D. Lizars Edinburgh.

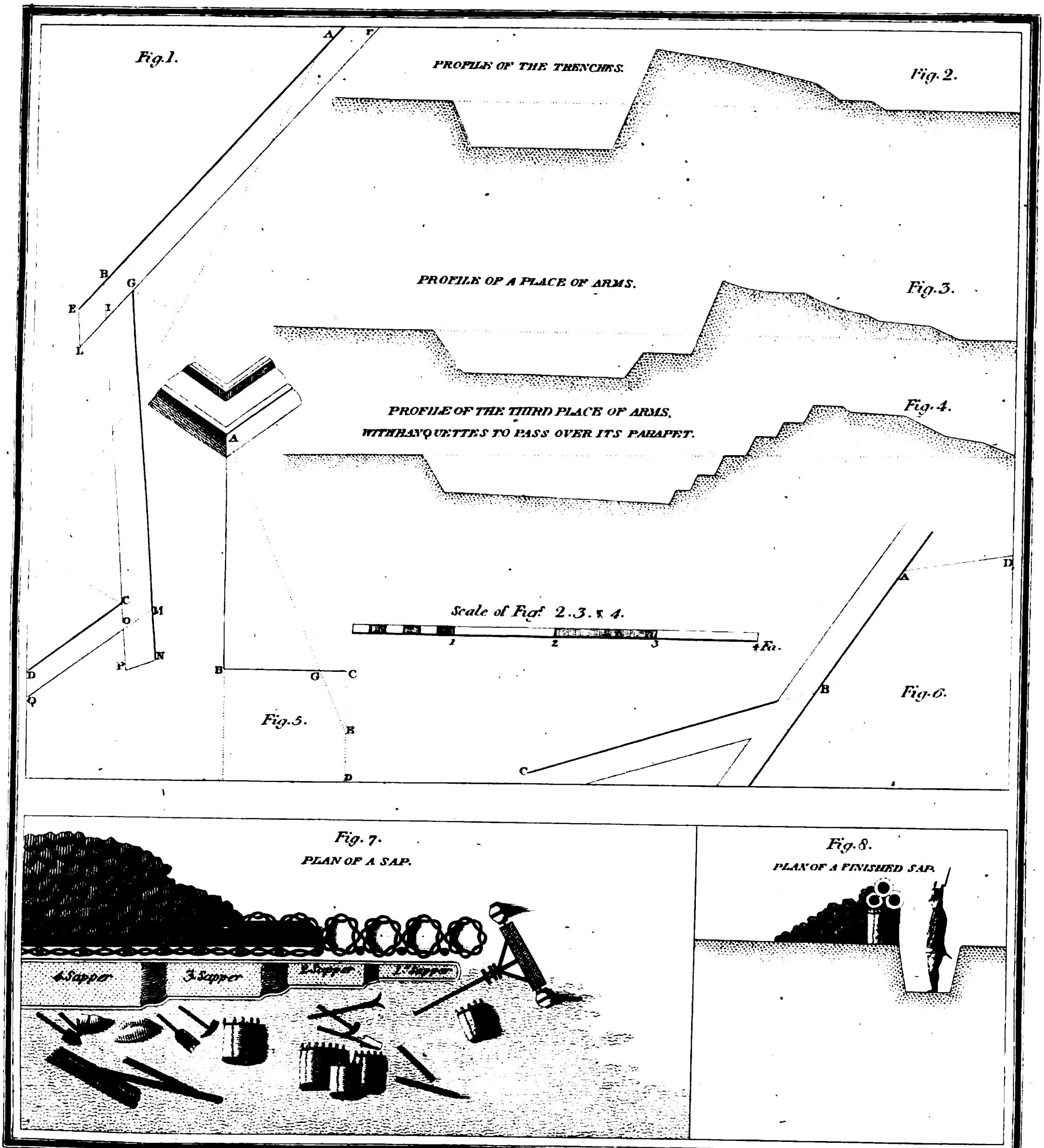
Fig. 1.





E. Mitchell sculp.

ATTACK OF FORTIFIED PLACES.



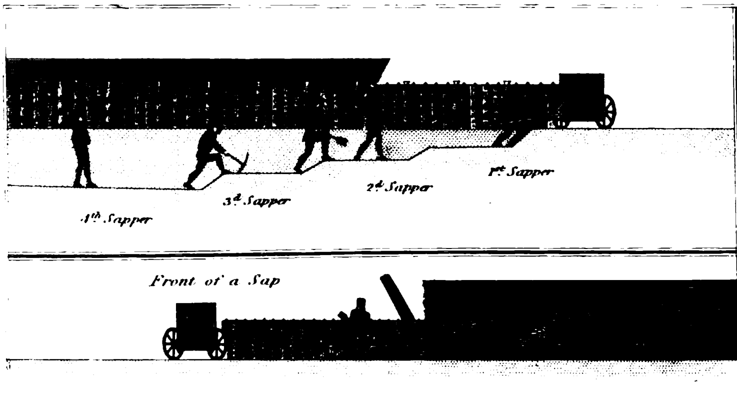
W. Archibald sculp.

Fig. 1

Back of a Sap

Fig. 2

Profile representing the excavation of 4 Sappers



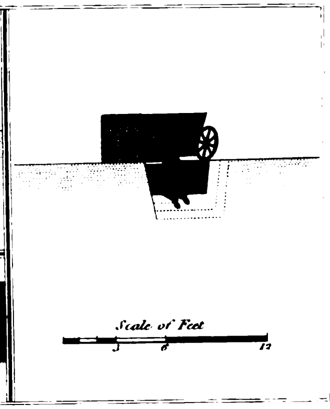
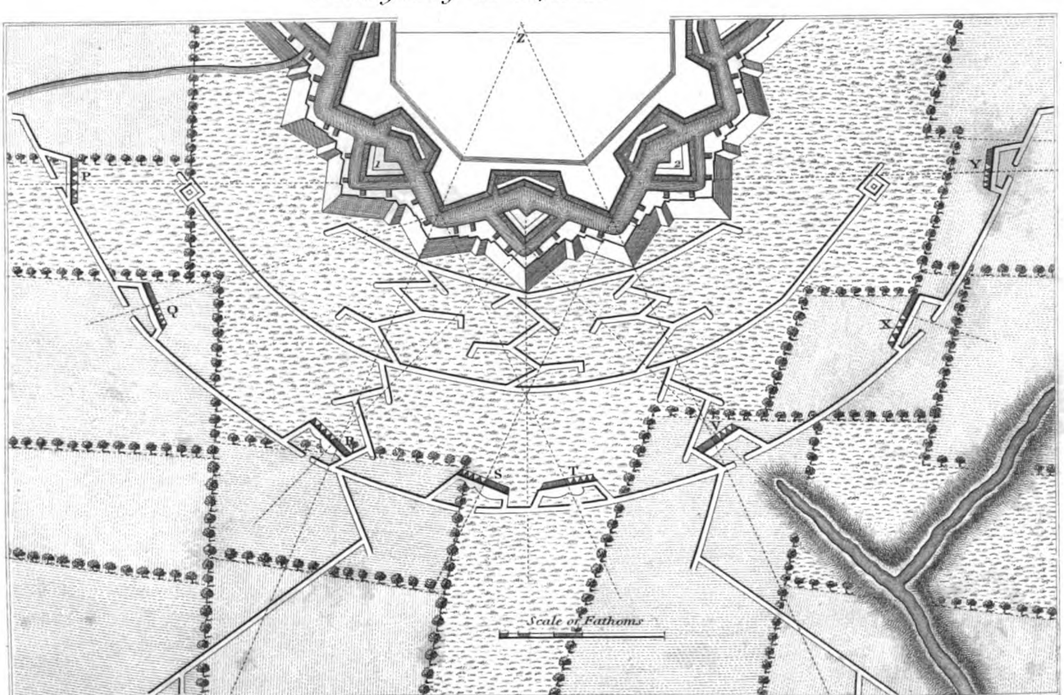


Fig. 3

Plan shewing the disposition of the Batteries



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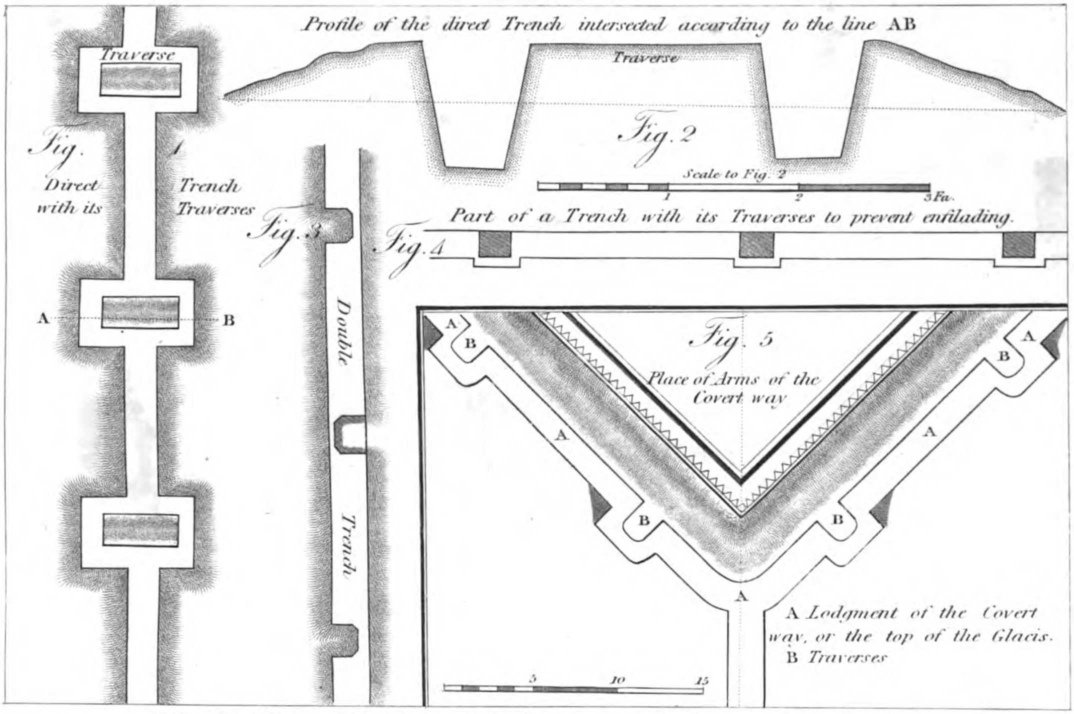
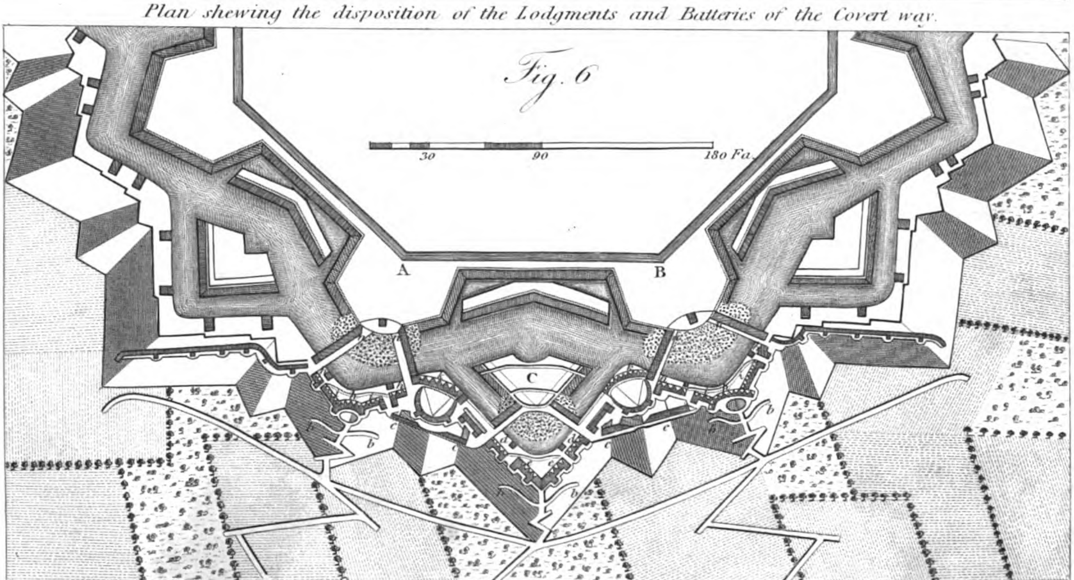
Attack of Fortified Places.



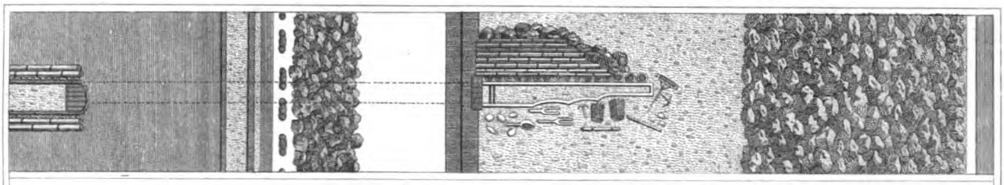
Plan shewing the disposition of the Lodgments and Batteries of the Covert way.



Smith sc. Clements Inn, Strand.

ATTACK of FORTIFIED PLACES.

Fig. 1.



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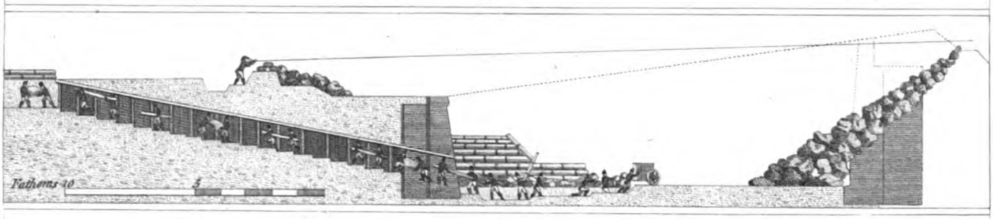
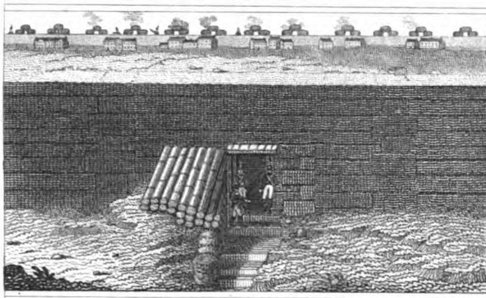


Entrance into the descent of a dry Ditch viewed from the top of the Breech.

Fig. 4.



Opening of the descent into the dry Ditch viewed from the Country.

Fig. 3.

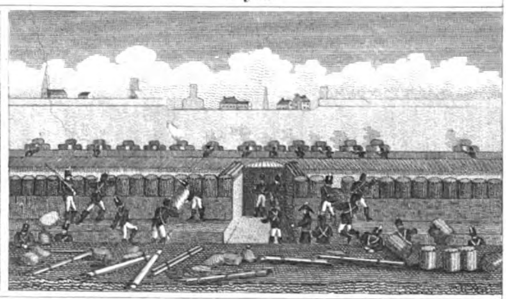
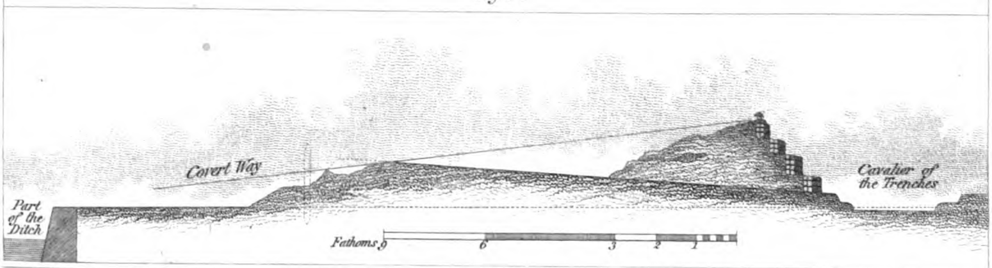


Fig. 5.



W. Archibald Sculp.

Attack of Fortified Places.

Fig. 1.

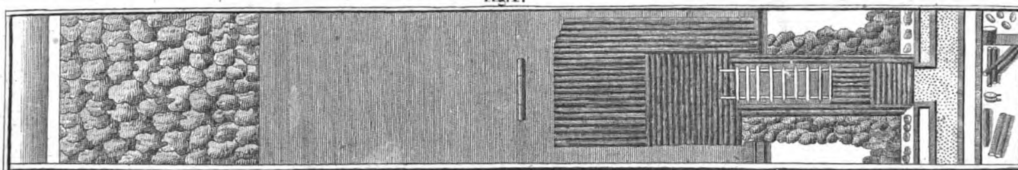
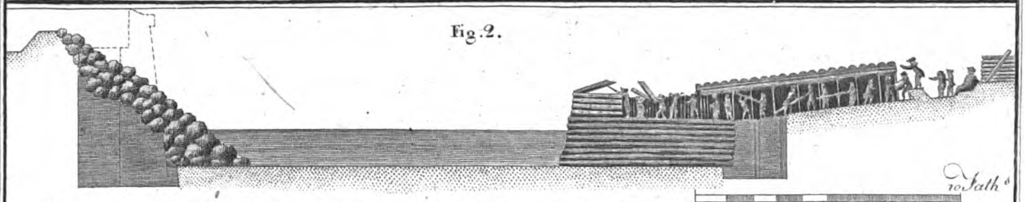
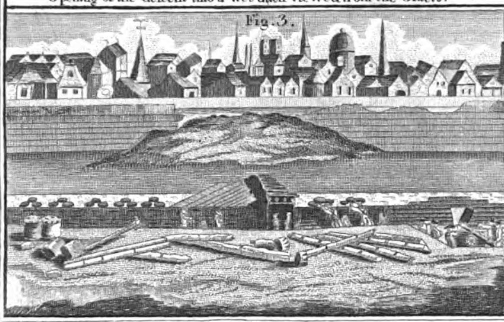


Fig. 2.



Opening of the descent into a wet ditch viewed from the Glacis.

Fig. 3.



Entrance into the descent of the wet ditch viewed from the Breach.

Fig. 4.

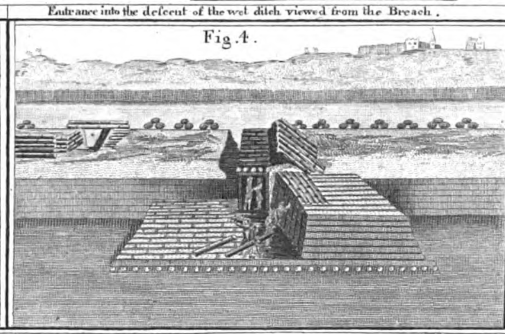
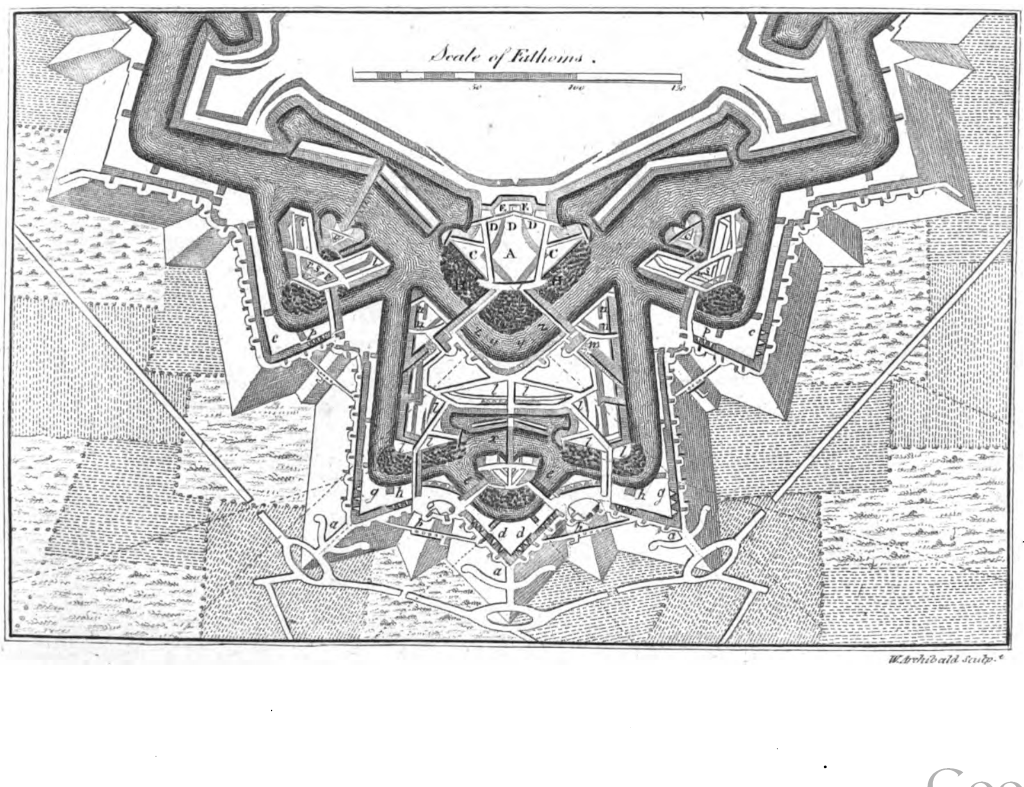


Fig. 5.



W. Archibald sculp.

ATTACK OF FORTIFIED PLACES

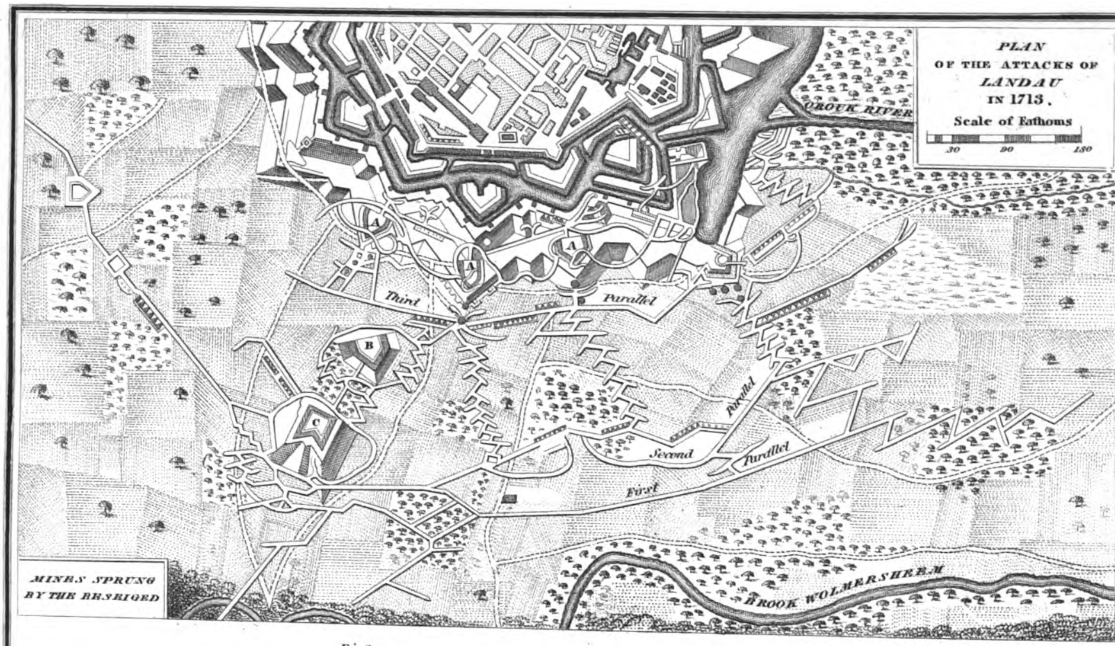
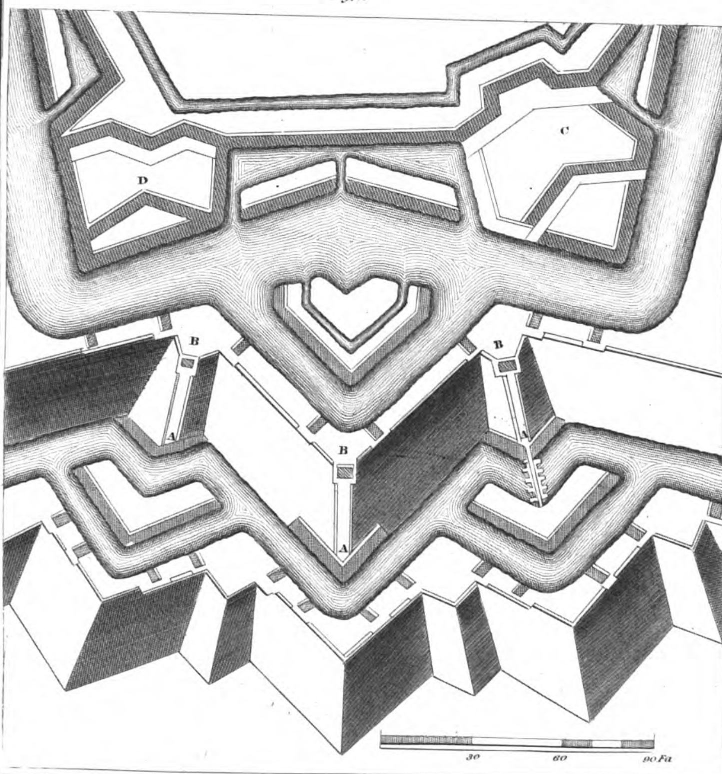


Fig. 2.



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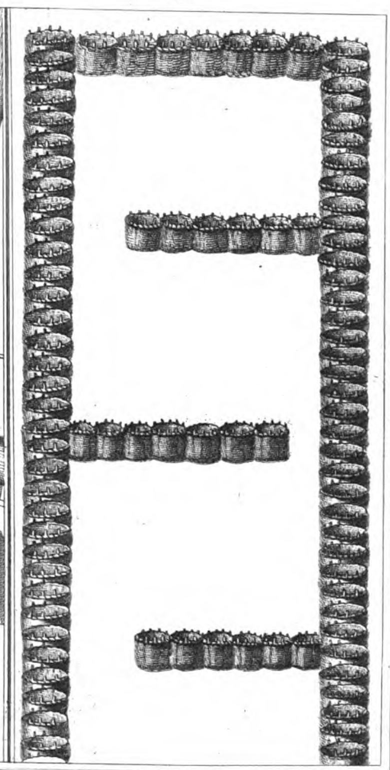

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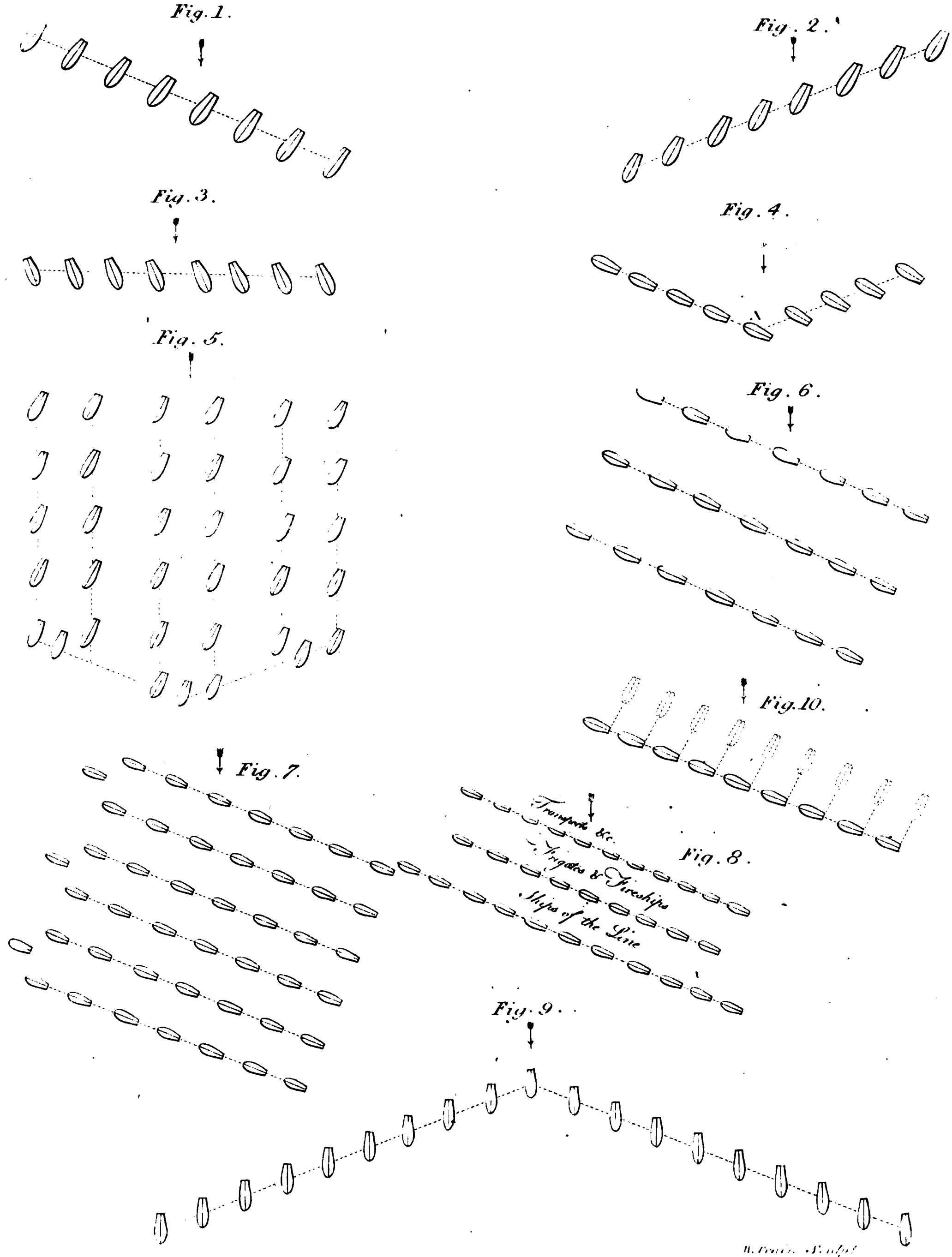
Fig. 1.
Fig. 2.
Fig. 3.
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Fig. 7.
Transports &c.
Frigates & Fireships
Ships of the Line
Fig. 8.
Fig. 9.

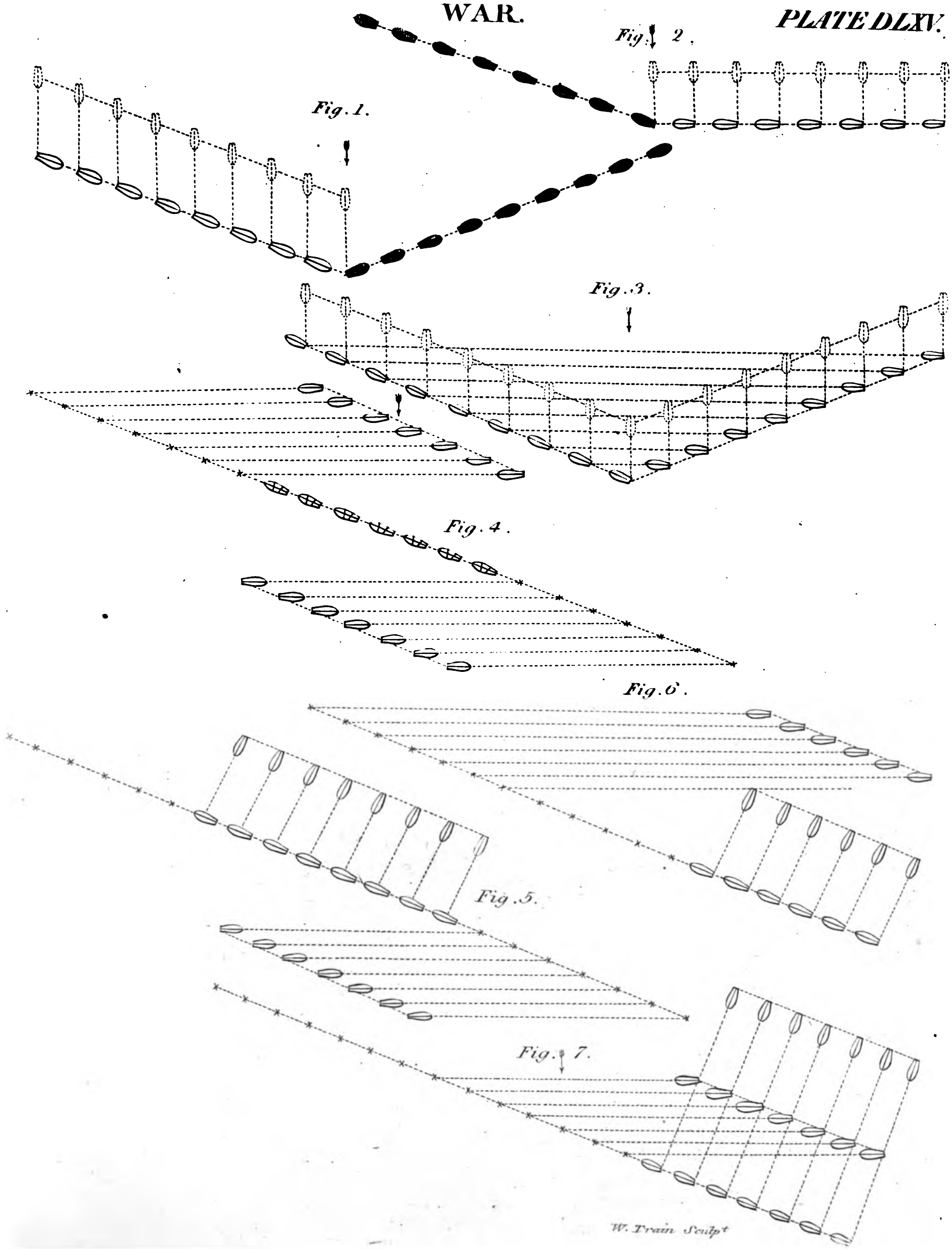
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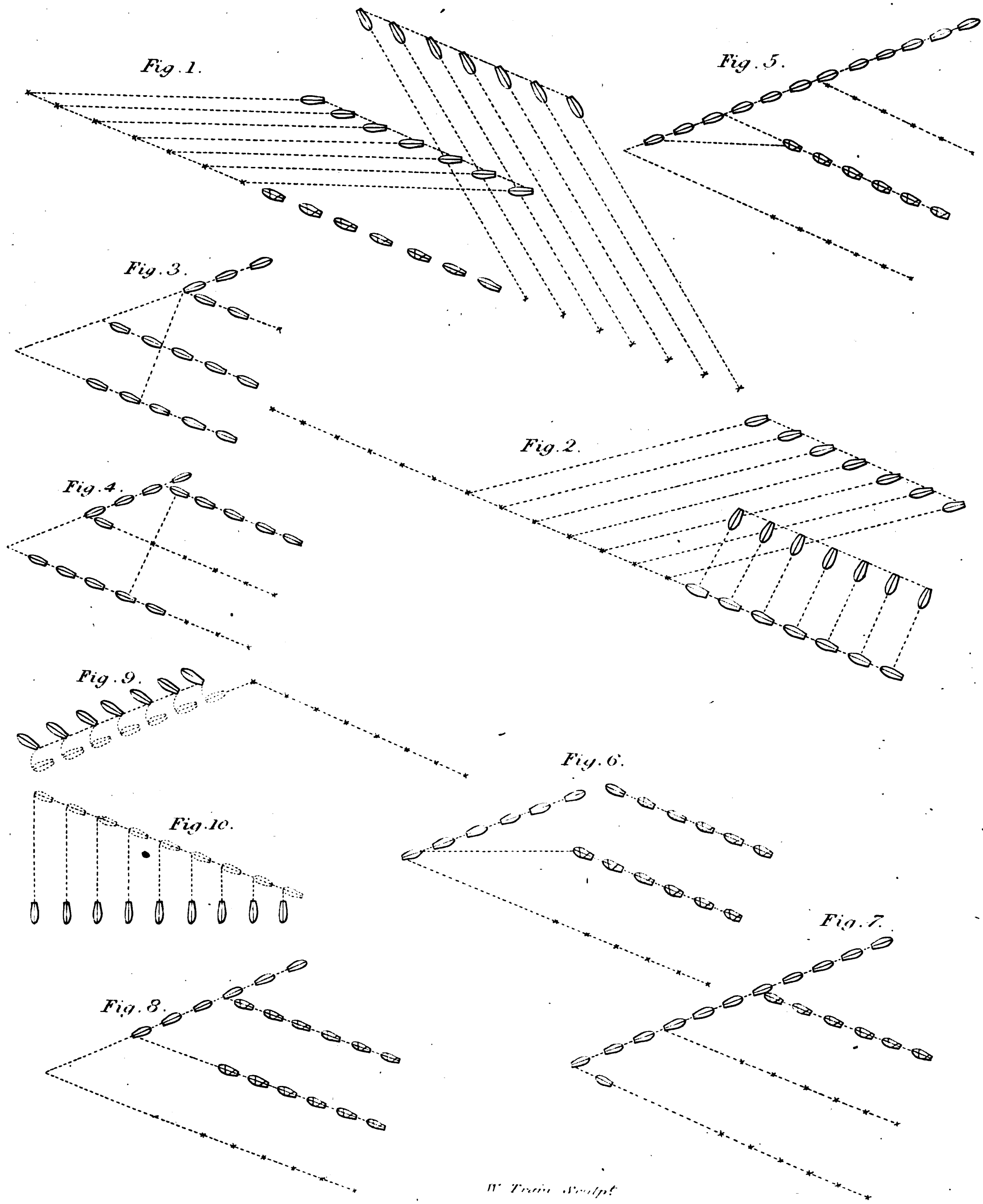
Fig. 7.
W. Train Sculpt.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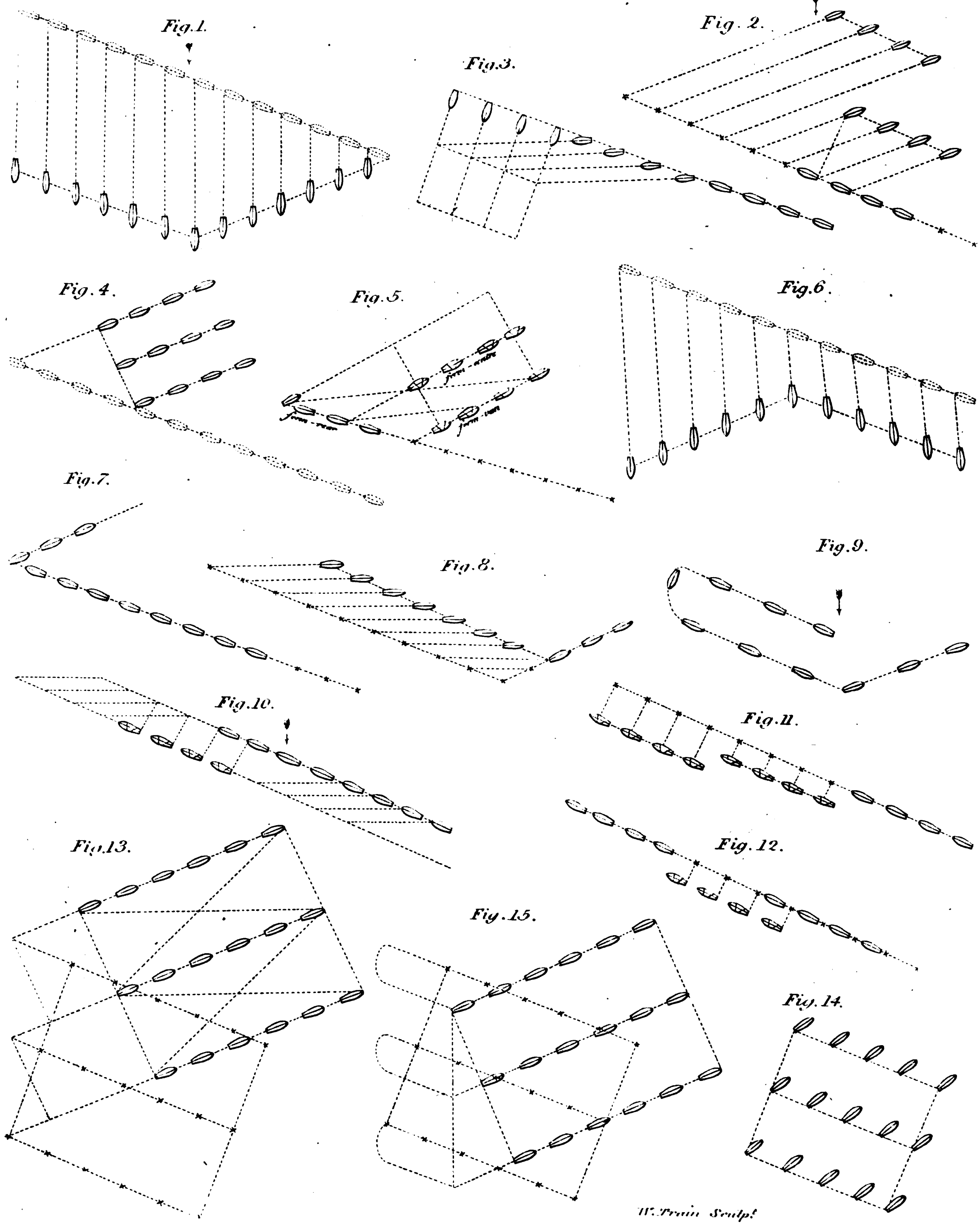
W. Train Sculpt.



W. Frain Sculp.t

Fig. 1.

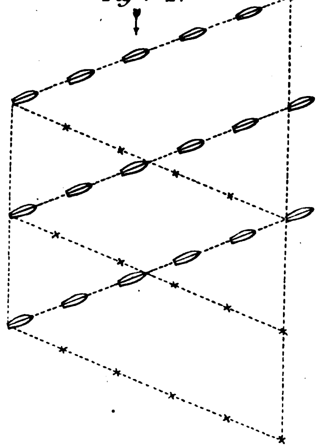
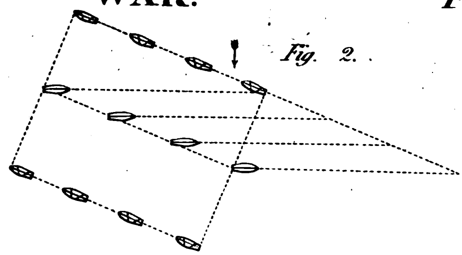


Fig. 2.



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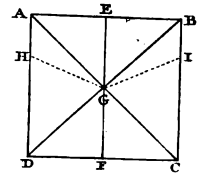

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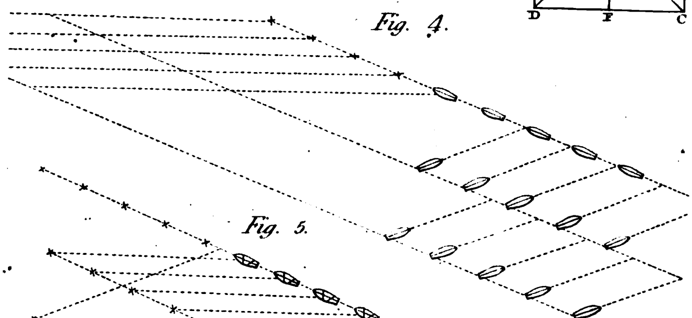

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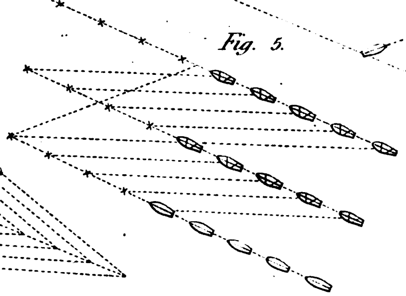
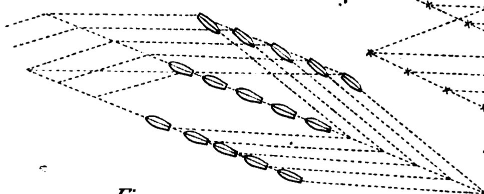


Fig. 3.



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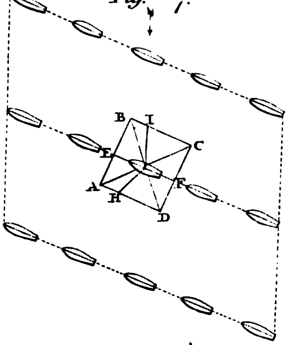

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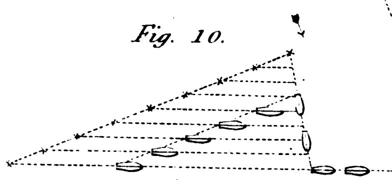

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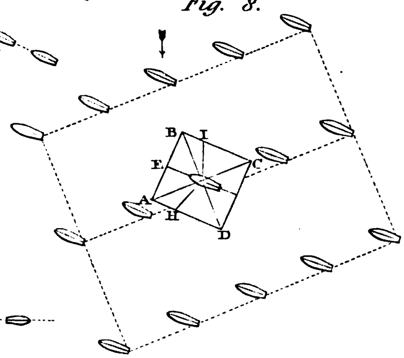

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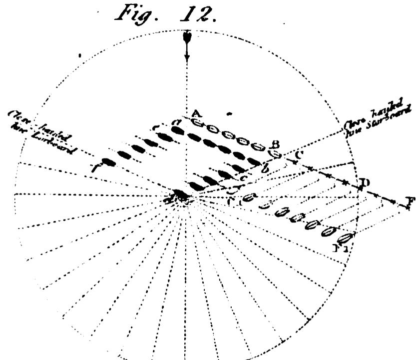

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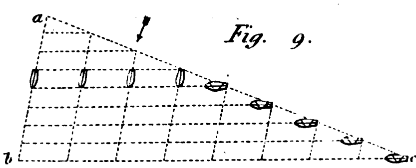
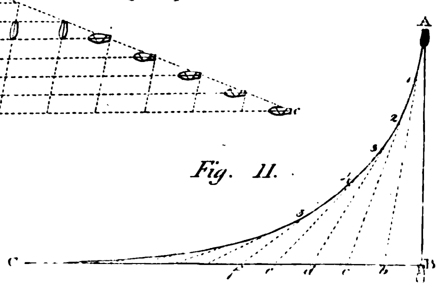
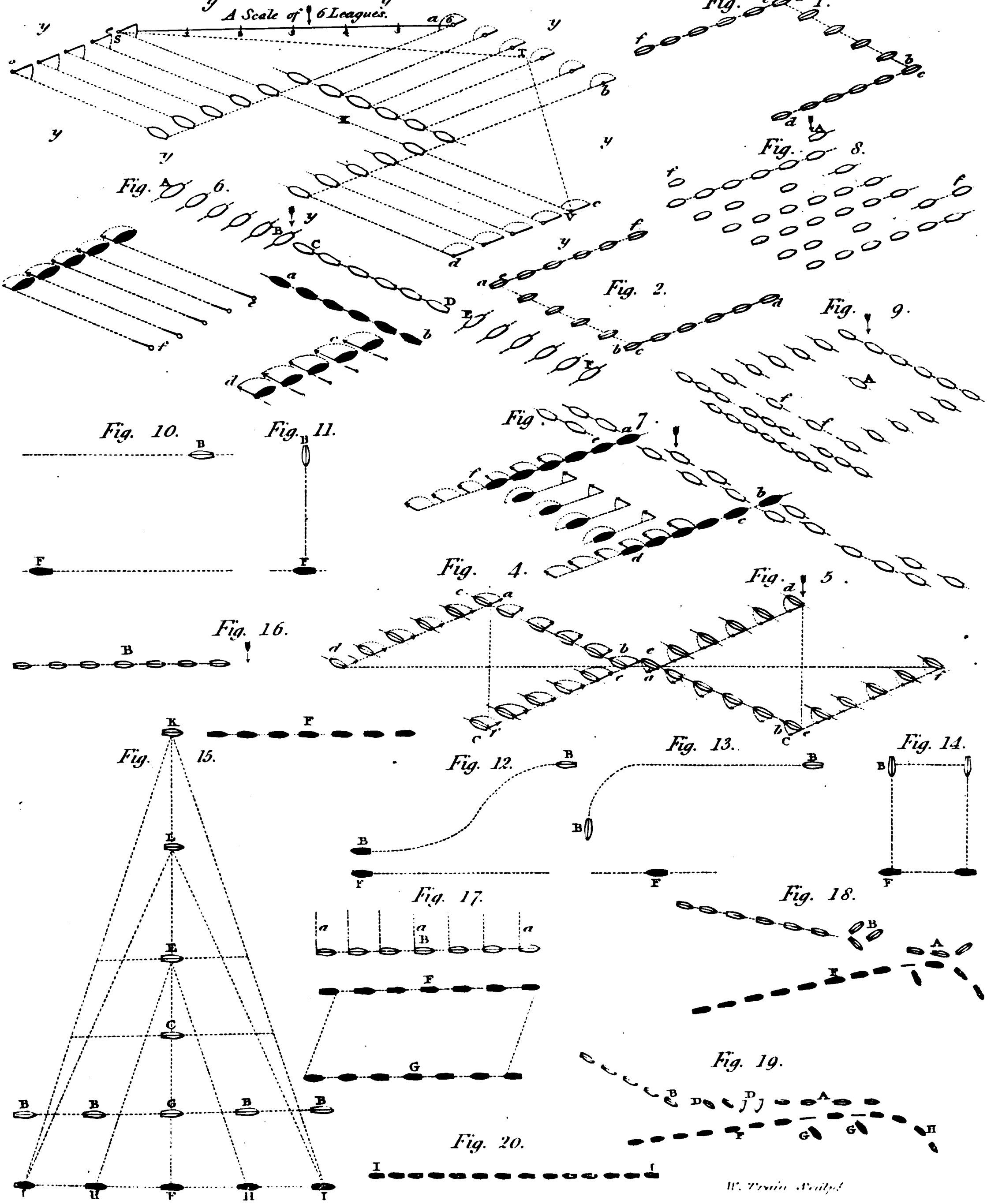
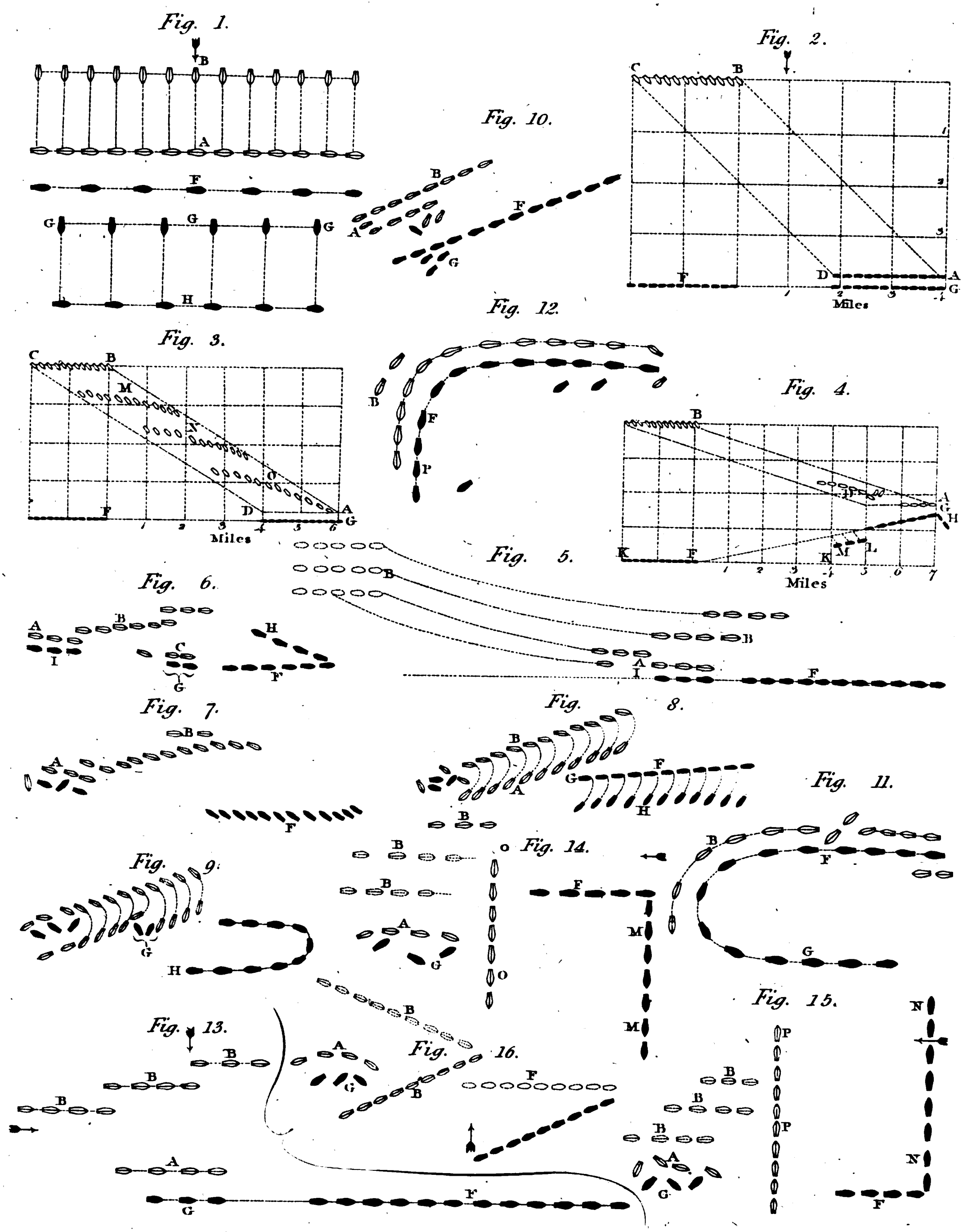


Fig. 11.





W. Train Sculpt.



W. Train Sculpt

Man-of-WAR Bird. See PELICANUS, ORNITHOLOGY *Index*.

WAR-Cry was formerly customary in the armies of most nations, when just upon the point of engaging. Sometimes they were only tumultuous shouts, or horrid yells, uttered with an intent to strike terror into their adversaries; such as is now used by the Indians in America, called the *war whoop*.

WARBLES, a disease of horses. See FARRIERY *Index*.

WARBURTON, WILLIAM, a learned English bishop, was descended from an ancient family in Cheshire, and was the second son of George Warburton, an attorney at Newark in the county of Nottingham, was born at Newark, December 24. 1698. He was first put to school there under a Mr Twells, but had the chief part of his education at Okeham in Rutlandshire, where he continued till the beginning of the year 1714, and soon after he was put out clerk to an eminent attorney of Greak Markham in Nottinghamshire, where he continued till the year 1719, when he returned to his family at Newark; but whether he practised there or elsewhere as an attorney, is not known.

He had always expressed a strong inclination to take orders; and the love of letters, which tended to retard, rather than forward, his progress in the profession chosen for him by his friends, growing every day stronger in him, it was deemed expedient to give way to that inclination. He therefore devoted himself to the studies necessary to fit him for the church, and at length in 1723 he was ordained deacon, and priest in 1727.

In 1728 he was presented by Sir Robert Sutton to the rectory of Brand-Broughton, in the diocese of Lincoln, where he spent the greater part of his life, and composed all the great works which will carry his fame down to posterity. In the same year he was put upon the king's list of Masters of Arts, erected on his majesty's visit to the university of Cambridge. He had already published some juvenile performances, which displayed genius and reading, and attracted considerable notice; but it was not till the year 1736 that he may be said to have emerged from the obscurity of a private life into the notice of the world.—The first publication which rendered him afterwards famous now appeared, under the title of "The Alliance between Church and State; or, the Necessity and Equity of an Established Religion and a Test Law; demonstrated from the Essence and End of Civil Society, upon the fundamental Principles of the Law of Nature and Nations." In this treatise, says Bishop Horsley *, the author "hath shown the general good policy of an establishment, and the necessity of a TEST for its security, upon principles which republicans themselves cannot easily deny. His work is one of the finest specimens that are to be found perhaps in any language, of scientific reasoning applied to a political subject."

* *Review of the Case of the Protestant Dissenters*, Lond. 1787, PREFACE.

At the close of the Alliance was announced the scheme of the Divine Legation of Moses, in which he had then made considerable progress. The first volume of this work was published in January 1737 8, under the title of "The Divine Legation of Moses demonstrated on the Principles of a religious Deist, from the Omision of the Doctrine of a future State of Rewards and Punishments in the Jewish Dispensation, in six books, by William Warburton, M. A. author of the Alliance between Church and State;" and met with a reception which neither the subject, nor the manner in which it was treated, seemed to authorise. It was, as the author afterwards observed, fallen upon in so outrageous and brutal a manner as had been scarce pardonable, had it been "The Divine Legation of Mahomet."—It produced several answers, and so much abuse from the authors of "The Weekly Miscellany," that in less than two months he was constrained to defend himself, in "A Vindication of the Author of the Divine Legation of Moses, from the Aspersions of the Country Clergyman's Letter in the Weekly Miscellany of February 24. 1737-8, 8vo."

Mr Warburton's extraordinary merit had now attracted the notice of the heir apparent to the crown, in whose immediate service we find him in June 1738, when he published "Faith working by Charity to Christian Edification, a Sermon, preached at the last episcopal Visitation for Confirmation in the Diocese of Lincoln; with a Preface, showing the Reason of its Publication; and a Postscript, occasioned by some Letters lately published in the Weekly Miscellany; by William Warburton, M. A. Chaplain to his Royal Highness the Prince of Wales."

The "Essay on Man" had now been published some years; and it is universally supposed, that the author had, in the composition of it, adopted the philosophy of Lord Bolingbroke, whom, on this occasion, he had followed as his guide, without understanding the tendency of his principles. In 1738, M. de Crousaz wrote some remarks on it, accusing the author of Spinozism and Naturalism; which falling into Mr Warburton's hands, he published a defence of the first epistle, and soon after of the remaining three, in seven letters; of which six were printed in 1739, and the seventh in June 1740, under the title of "A Vindication of Mr Pope's Essay on Man, by the author of the Divine Legation." The opinion which Mr Pope conceived of these defences, as well as of their author, will be best seen in his letters. In consequence, a firm friendship was established between them, which continued with undiminished fervour until the death of Mr Pope; who, during the remainder of his life, paid a deference and respect to his friend's judgment and abilities, which will be considered by many as almost bordering on servility.

Towards the end of the year 1739, Mr Warburton published a new and improved edition of the first volume of the Divine Legation; and in 1741, appeared the second part, which completed the argument, though not the entire plan of that work. "A work, says Bishop Hurd *, in all views of the most transcendant merit, whether we consider the invention or the execution. A plain simple argument, yet perfectly new, proving the divinity of the Mosaic law, and laying a sure foundation for the support of Christianity, is there drawn out to a great length by a chain of reasoning so elegantly connected, that the reader is carried along it with ease and pleasure; while the matter presented to him is so striking for its own importance, so embellished by a lively fancy, and illustrated from all quarters by exquisite learning and the most ingenious disquisition, that in the whole compass of modern or ancient theology, there is nothing equal or similar to this extraordinary performance."

* *Life of Warburton prefixed to his Works.*

This is the panegyric of a man reflecting with tenderness

derness on the memory of his friend and benefactor; but it approaches much nearer to the truth than the censures of those cabalistic critics, who, fastening upon some weak part of the Divine Legation, or perhaps never having looked into it, have ridiculously contended that the author was far from being eminent as a scholar, and that his work is inimical to the cause of Christianity! Putting partiality aside, there is in the Divine Legation of Moses abundant evidence of the malignant folly of this charge, as no man can read and understand that work without being convinced that its author was a Christian, not only sincere but zealous; that he was, what Johnson calls him*, "a man of vigorous faculties, of a mind fervent and vehement, supplied, by unlimited and incessant inquiry, with a wonderful extent and variety of knowledge, which had neither depressed his imagination nor clouded his perspicuity; and that to every work, and this work in particular, he brought a memory full fraught, with a fancy fertile of original combinations, exerting at once the powers of the scholar, the reasoner, and the wit." But we think it must be acknowledged, that his learning was too multifarious to be always exact, and his inquiries too eagerly pushed to be always cautious. We have no hesitation, however, to say, that to the divine this great work, with all its imperfections, is, in our opinion, one of the most valuable that is to be found in any language.

* *Life of Pope.*

In the summer 1741, Mr Pope and Mr Warburton, in a country ramble, took Oxford in their way. The university was naturally pleased at the arrival of two such strangers, and seemed desirous of enrolling their names among their graduates. The degree of D. D. was intended for the divine, and that of LL. D. for the poet: but intrigue and envy defeated this scheme; and the university lost the honour of decorating at the same time the two greatest geniuses of the age, by the fault of one or two of its members. Pope retired with some indignation to Twickenham, where he consoled himself and his friend with this sarcastic reflection—"We shall take our degree together in fame, whatever we do at the university."

The friendship of this eminent poet was of service to Mr Warburton in more respects than that of increasing his fame. He introduced and warmly recommended him to most of his friends, and among others to Mr Murray, afterwards earl of Mansfield, and Ralph Allen, Esq. of Prior-park. In consequence of this introduction, we find Mr Warburton at Bath 1742; where he printed a sermon which had been preached at the Abbey-church on the 24th of October, for the benefit of Mr Allen's favourite Charity, the General Hospital or Infirmary. In this year also he printed a Dissertation on the origin of books of chivalry, at the end of Jarvis's Preface to a translation of Don Quixote, which Mr Pope tells him, he had not got over two paragraphs of, before he cried out, *Aut Erasmus, aut Diabolus.*

In 1742, Mr Warburton published "A Critical and Philosophical Commentary on Mr Pope's Essay on Man, in which is contained a Vindication of the said Essay from the Misrepresentation of M. de Resnal, the French Translator, and of M. de Crousaz, Professor of Philosophy and Mathematics in the Academy of Lausanne, the Commentator." It was at this period, when Mr Warburton had the entire confidence of Mr Pope, that he advised him to complete the Dunciad, by changing the hero, and adding to it a fourth book. This was accordingly executed in 1742, and published early in 1743, with notes by our author; who, in consequence of it, received his share of the abuse which Mr Cibber liberally bestowed on both Mr Pope and his annotator. In the latter end of the same year he published complete editions of "The Essay on Man," and "The Essay on Criticism;" and from the specimen which he there exhibited of his abilities, it may be presumed Mr Pope determined to commit the publication of those works which he should leave to Mr Warburton's care. At Mr Pope's desire, he, about this time, revised and corrected the "Essay on Homer," as it now stands in the last edition of that translation.

The publication of "The Dunciad" was the last service which our author rendered Mr Pope in his life time. After a lingering and tedious illness, the event of which had been long foreseen, this great poet died on the 30th of May 1744; and by his will, dated the 12th of the preceding December, bequeathed to Mr Warburton one half of his library, and the propery of all such of his works already printed as he had not otherwise disposed of or alienated, and all the profits which should arise from any edition to be printed after his death: but at the same time directed that they should be published without any future alterations.

"In 1744, Mr Warburton turned his attention to the several attacks which had been made on the "Divine Legation," and defended himself in a manner which, if it did not prove him to be possessed of much humility or diffidence, at least demonstrated, that he knew how to wield the weapons of controversy with the hand of a master. His first defence now appeared, under the title of "Remarks on several occasional Reflections, in Answer to the Reverend Dr Middleton, Dr Pococke, the Master of the Charter-house, Dr Richard Grey, and others; serving to explain and justify divers Passages in the Divine Legation, objected to by those learned Writers. To which is added, A general Review of the Argument of the Divine Legation, as far as it is yet advanced; wherein is considered the Relation the several Parts bear to each other and the whole. Together with an Appendix, in Answer to a late Pamphlet intitled, An Examination of Mr W——'s second Proposition." This was followed next year by "Remarks on several occasional Reflections, in Answer to the Reverend Doctors Stebbing and Sykes; serving to explain and justify the Two Dissertations in the Divine Legation, concerning the command to Abraham to offer up his Son, and the Nature of the Jewish Theocracy, objected to by these learned Writers. Part II. and last." Both these answers are couched in those high terms of confident superiority, which marked almost every performance that fell from his pen during the remainder of his life.

On the 5th of September 1745, the friendship between him and Mr Allen was more closely cemented by his marriage with Miss Tucker, who survived, and is now, if alive, Mrs Stafford Smith of Prior-park. At that important crisis our author preached and published three seasonable sermons: 1. "A faithful Portrait of Popery, by which it is seen to be the Reverse of Christianity, as it is the Destruction of Morality, Piety, and Civil Liberty. Preached at St James's, Westminster, October

Warburton. October 1745." 2. A Sermon occasioned by the present unnatural Rebellion, &c, Preached in Mr Allen's Chapel at Prior park, near Bath, November 1745." 3. "The Nature of National Offences truly stated.—Preached on the General Fast-day, Dec. 18. 1745-6." On account of the last of these sermons, he was again involved in a controversy with his former antagonist Dr Stebbing, which occasioned "An Apologetical Dedication to the Reverend Dr Henry Stebbing, in Answer to his Censure and Misrepresentations of the Sermon preached on the General Fast, &c.

Notwithstanding his great connections, his acknowledged abilities, and his established reputation, a reputation founded on the durable basis of learning, and upheld by the decent and attentive performance of every duty incident to his station; yet we do not find that he received any addition to the preferments given him in 1728 by Sir Robert Sutton (except the chaplainship to the prince of Wales), until April 1746, when he was unanimously called by the Society of Lincoln's Inn to be their preacher. In November he published "A Sermon preached on the Thanksgiving appointed to be observed the 9th of October, for the Suppression of the late unnatural Rebellion." In 1747 appeared his edition of Shakespeare and his Preface to Clarissa; and in the same year he published, 1. "A Letter from an Author to a Member of Parliament concerning Literary Property." 2. "Preface to Mrs Cockburn's Remarks upon the Principles and Reasonings of Dr Rutherford's Essay on the Nature and Obligations of Virtue, &c." 3. "Preface to a Critical Inquiry into the Opinions and Practice of the ancient Philosophers, concerning the Nature of a Future State, and their Method of teaching by double Doctrine," (by Mr Towne) 1747, second edition. In 1748, a third edition of "The Alliance between Church and State, corrected and enlarged."

"In 1749, a very extraordinary attack was made on the moral character of Mr Pope, from a quarter where it could be least expected. An insignificant pamphlet, under the name of *A Patriot King*, was that year published by Lord Bolingbroke, or by his direction, with a preface to it, reflecting highly on Mr Pope's honour. The provocation was simply this: The manuscript of that trivial declamation had been intrusted to the care of Mr Pope, with the charge (as it was pretended) that only a *certain* number of copies should be printed. Mr Pope, in his excessive admiration of his *guide*, *philosopher*, and friend, took that opportunity, for fear so invaluable a treasure of patriot eloquence should be lost to the public, to exceed his commission, and to run off more copies, which were found, after his death, in the printer's warehouse. This charge, however frivolous, was aggravated beyond measure; and, notwithstanding the proofs which Lord Bolingbroke, had received of Pope's devotion to him, envenomed with the utmost malignity. Mr Warburton thought it became him to vindicate his deceased friend; and he did it so effectually, as not only to silence his accuser, but to cover him with confusion *."

* *Hurd's Life of Warburton.*

About this time the publication of Dr Middleton's Inquiry concerning the miraculous Powers of the Christian church, gave rise to a controversy, which was managed with great warmth and asperity on both sides, and not much to the credit of either party. On this occasion Mr Warburton published an excellent performance, written with a degree of candour and temper, which, it is to be lamented, he did not always exercise. The title of it was "Julian; or a Discourse concerning the Earthquake and fiery Eruption which defeated that Emperor's attempt to rebuild the Temple at Jerusalem, 1750." A second edition of this discourse, "with Additions," appeared in 1751, in which year he gave the public his edition of Mr Pope's Works, with Notes, in nine volumes 8vo.; and in the same year printed "An Answer to a Letter to Dr Middleton, inserted in a Pamphlet intitled, The Argument of the Divine Legation fairly stated," &c.; and "An Account of the Prophecies of Arise Evans, the Welsh Prophet in the last Century," annexed to the first volume of Dr Jortin's Remarks on Ecclesiastical History, which afterwards subjected him to much trouble.

In 1752, Mr Warburton published the first volume of a course of sermons, preached at Lincoln's Inn, intitled, "The Principles of Natural and Revealed Religion, occasionally opened and explained;" and this was two years afterwards followed by a second. After the public had been some time promised, it may, from the alarm which was taken, be almost said threatened with, the appearance of Lord Bolingbroke's Works, they were about this time printed. The known abilities and infidelity of this nobleman had created apprehensions in the minds of many people, of the pernicious effects of his doctrines; and nothing but the appearance of his whole force could have convinced his friends, how little there was to be dreaded from arguments against religion so weakly supported. Many answers were soon published, but none with more acuteness, solidity, and sprightliness, than "A view of Lord Bolingbroke's Philosophy, in two Letters to a Friend, 1754;" the third and fourth letters were published in 1755, with another edition of the two former; and in the same year a smaller edition of the whole; which, though it came into the world without a name, was universally ascribed to Mr Warburton, and afterwards publicly owned by him. To some copies of this is prefixed an excellent complimentary epistle from the president Montesquieu, dated May 26. 1754.

At this advanced period of his life, that preferment which his abilities might have claimed, and which had hitherto been withheld, seemed to be approaching towards him. In September 1754, he was appointed one of his majesty's chaplains in ordinary; and in the next year was presented to a prebend in the cathedral of Durham. About this time the degree of Doctor of Divinity was conferred on him by Dr Herring, then archbishop of Canterbury. A new impression of the Divine Legation being now called for, he printed a fourth edition of the first part of it, corrected and enlarged, divided into two volumes, with a dedication to the earl of Hardwicke. The same year appeared "A Sermon preached before his Grace Charles Duke of Marlborough, President, and the Governors of the Hospital for the Smallpox and for Inoculation, at the Parish-church of St Andrew, Holborn, April the 24th, 1755." And in 1756, Natural and Civil Events the Instruments of God's Moral Government; a Sermon, preached on the last public Fast-day, at Lincoln's Inn Chapel."

In 1757, Dr Warburton meeting with Mr Hume's

 tract,

Warburton. tract, entitled, The Natural History of Religion, filled the margin of the book, as well as some interleaved slips of paper, with many severe and shrewd remarks on the infidelity and naturalism of the author. These he put into the hands of his friend Dr Hurd, who, making a few alterations of the style, added a short introduction and conclusion, and published them in a pamphlet, entitled, "Remarks on Mr David Hume's Natural History of Religion, by a Gentleman of Cambridge, in a Letter to the Reverend Dr Warburton." This lively attack upon Mr Hume gave him so much offence, that he thought proper to vent his spleen on the supposed author, in the posthumous discourse which he called his *Life*; and thus to do greater honour to Dr Hurd than to any other of his numerous antagonists.

Towards the end of the year 1757, Dr Warburton was promoted to the deanery of Bristol; and in the beginning of the year 1760, he was, through Mr Allen's interest with Mr Pitt, afterwards earl of Chatham, advanced to the bishopric of Gloucester. That great minister is known to have declared, "that nothing of a private nature, since he had been in office, had given him so much pleasure as bringing our author on the bench." There was, however, another minister, who dreaded his promotion, and thought he saw a second Atterbury in the new bishop of Gloucester; but Warburton, says Bishop Hurd, had neither talents nor inclination for parliamentary intrigue or parliamentary eloquence: he had other instruments of fame in his hands, and was infinitely above the vanity of being caught

"With the fine notion of a busy man*."

* *Dryden.*

He was consecrated on the 20th of January 1760, and on the 30th of the same month preached before the house of lords. In the next year he printed "A Rational Account of the Nature and End of the Sacrament of the Lord's Supper." In 1762, he published "The Doctrine of Grace; or the Office and Operations of the Holy Spirit vindicated from the Insults of Infidelity and the Abuses of Fanaticism," 2 vols 12mo; and in the succeeding year drew upon himself much illiberal abuse from some writers of the popular party, on occasion of his complaint in the house of lords, on the 15th of November 1763, against Mr Wilkes, for putting his name to certain notes on the infamous "Essay on Woman."

In 1765 he published a new edition of the second part of the Divine Legation, in three volumes; and as it had now received his last hand, he presented it to his great friend Lord Mansfield, in a dedication which deserves to be read by every person who esteems the well-being of society as a concern of any importance. It was the appendix to this edition which produced the well-known controversy between him and Dr Lowth, which we have noticed elsewhere (see LOWTH), as doing no great honour, by the mode in which it was conducted, to either party. In the next year he gave a new and much improved edition of the Alliance between the Church and State. This was followed, in 1767, by a third volume of sermons, to which is added, his first Triennial Charge to the Clergy of the Diocese of Gloucester; which may be safely pronounced one of the most valuable discourses of the kind that is to be found in our own or any other language. With this publication he closed his literary course; except that he made an effort towards publishing, and actually printed, the ninth and last book of the Divine Legation. This book, with one or two occasional sermons, and some valuable directions for the study of *theology*, have been given to the world in the splendid edition of his works in seven volumes 4to, by his friend and biographer the present bishop of Worcester. That prelate confesses, that the ninth book of the Divine Legation displays little of that vigour of mind and fertility of invention which appear so conspicuous in the former volumes; but he adds, perhaps truly, that under all the disadvantages with which it appears, it is the noblest effort which has hitherto been made to give a *rationale* of Christianity.

While the bishop of Gloucester was thus exerting his last strength in the cause of religion, he projected a method by which he hoped to render it effectual service after his death. He transferred 500l. to Lord Mansfield, Sir Eardley Wilmot, and Mr Charles Yorke, upon trust, to found a lecture, in the form of a course of sermons, to prove the truth of revealed religion in general, and of the Christian in particular, from the completion of the prophecies in the Old and New Testament, which relate to the Christian church, especially to the apostasy of Papal Rome. To this foundation we owe the admirable Introductory Lectures of Hurd, and the well-adapted Continuation of Halifax and Bagot.

It is a melancholy reflection, that a life spent in the constant pursuit of knowledge, frequently terminates in the loss of those powers, the cultivation and improvement of which are attended to with too strict and unabated a degree of ardour. This was the case with Dr Warburton; and it seems probable that this decline of intellectual vigour was aggravated by the loss of his only son, a promising young man, who died of a consumption but a short time before the bishop, who himself resigned to fate in the year 1779, and in the 81st of his age. A neat marble monument was erected to his memory in the cathedral of Gloucester.

Ward. WARD, Dr SETH, an English prelate, chiefly distinguished for his knowledge in mathematics and astronomy, was born at Buntingford in Hertfordshire, about the year 1617. He was admitted of Sidney college, Cambridge, where he applied with great vigour to his studies, particularly to the mathematics, and was chosen fellow of his college. He was much involved in the consequences of the civil war, but soon after the Restoration obtained the bishopric of Exeter; in 1667, he was translated to Salisbury; and in 1671 was made chancellor of the order of the Garter; he was the first Protestant bishop that enjoyed that honour, and he procured it to be annexed to the see of Salisbury. Bishop Ward was one of those unhappy persons who have the misfortune to survive their senses, which happened in consequence of a fever ill cured; he lived to the Revolution, without knowing any thing of the matter, and died in 1690. He was the author of several Latin works in mathematics and astronomy, which were thought excellent in their day; but their use has been superseded by later discoveries and the Newtonian philosophy.

WARD, is variously used in our old books: a ward in London is a district or division of the city, committed to the special charge of one of the aldermen; and in London there are 26 wards, according to the number of the mayor and aldermen, of which every one has his

Ward | Wardrobe.

his ward for his proper guard and jurisdiction. A forest is divided into wards; and a prison is called a *ward*. Lastly, the heir of the king's tenant, that held *in capite*, was termed a *ward* during his nonage; but this wardship is taken away by the statute 12 Car. II. c. 24.

WARD-Holding, in *Scots Law*. See LAW, N° clxv. 1. and clxvi. 3.

WARD-Hook, or *Wadd-hook*, in *Gunnery*, a rod or staff, with an iron end turned serpentwise, or like a screw, to draw the wadding out of a gun when it is to be unloaded.

WARDEN, or GUARDIAN, one who has the charge or keeping of any person, or thing, by office. Such is the warden of the Fleet, the keeper of the Fleet prison; who has the charge of the prisoners there, especially such as are committed from the court of chancery for contempt.

WARDHUYS, a port of Norwegian Lapland, 120 miles south-east of the North Cape. E. Long. 31. 12. N. Lat. 70. 23.

WARDMOTE, in London, is a court so called, which is kept in every ward of the city; answering to the *curiata comitia* of Rome.

WARDROBE, a closet or little room adjoining to a bedchamber, serving to dispose and keep a person's apparel in; or for a servant to lodge in, to be at hand to wait, &c.

WARDROBE, in a prince's court, is an apartment wherein his robes, wearing apparel, and other necessaries, are preserved under the care and direction of proper officers.

In Britain, the *Master or Keeper of the Great Wardrobe* was an officer of great antiquity and dignity. High privileges and immunities were conferred on him by King Henry VI. which were confirmed by his successors; and King James I. not only enlarged them, but ordained that this office should be a corporation or body politic for ever.

It was the duty of this office to provide robes for the coronations, marriages, and funerals of the royal family; to furnish the court with hangings, cloths of state, carpets, beds, and other necessaries; to furnish houses for ambassadors at their first arrival; cloths of state, and other furniture, for the lord lieutenant of Ireland, and all his majesty's ambassadors abroad; to provide all robes for foreign knights of the garter, robes for the knights of the garter at home; robes and all other furniture for the officers of the garter; coats for kings, heralds, and pursuivants at arms; robes for the lords of the treasury, and chancellor of the exchequer, &c.; livery for the lord chamberlain, grooms of his majesty's privy chamber, officer of his majesty's robes; for the two chief justices, for all the barons of the exchequer, and several officers of these courts; all liveries for his majesty's servants, as yeomen of the guard, and wardens of the Tower, trumpeters, kettle-drummers, and fifes; the messengers, and all belonging to the stables, as coachmen, footmen, littermen, postilions, and grooms, &c. all the king's coaches, chariots, harnesses, saddles, bits, bridles, &c. the king's watermen, game-keepers, &c. also furniture for the royal yachts, and all rich embroidered tilts, and other furniture for the barges.

Beatson's Political Index, vol. ii.

Besides the master or keeper of the wardrobe, who had a salary of 2000l. there was his deputy, who had 150l. and a comptroller and a patent clerk, each of whom had a salary of 300l. Besides many other inferior officers and servants, who were all sworn servants to the king.

Wardrobe, | Wardship.

There was likewise a removing wardrobe, who had its own set of officers, and standing wardrobe-keepers at St James's, Windsor Castle, Hampton Court, Kensington, and Somerset House; but the whole of the wardrobe establishment was abolished by act of parliament in 1782, and the duty of it in future to be done by the lord chamberlain.

WARDSHIP, in chivalry, one of the incidents of tenure by knight-service. See *FEODAL System*, *KNIGHT Service*, and TENURE.

Upon the death of a tenant, if the heir was under the age of 21, being a male, or 14, being a female, the lord was intitled to the wardship of the heir, and was called the *guardian in chivalry*. This wardship consisted in having the custody of the body and lands of such heir, without any account of the profits, till the age of 21 in males, and 16 in females. For the law supposed the heir-male unable to perform knight-service till 21; but as for the female, she was supposed capable at 14 to marry, and then her husband might perform the service. The lord therefore had no wardship, if at the death of the ancestor the heir-male was of the full age of 21, or the heir-female of 14: yet if she was then under 14, and the lord once had her in ward, he might keep her so till 16, by virtue of the statute of Westminster, 1. 3 Edw. I. c. 22. the two additional years being given by the legislature for no other reason but merely to benefit the lord.

This wardship, so far as it related to land, though it was not nor could be part of the law of feuds, so long as they were arbitrary, temporary, or for life only; yet when they became hereditary, and did consequently often descend upon infants, who by reason of their age could neither perform nor stipulate for the services of the feud, does not seem upon feudal principles to have been unreasonable. For the wardship of the land, or custody of the feud, was retained by the lord, that he might out of the profits thereof provide a fit person to supply the infant's services till he should be of age to perform them himself. And if we consider a feud in its original import, as a stipend, fee, or reward for actual service, it could not be thought hard that the lord should withhold the stipend so long as the service was suspended. Though undoubtedly to our English ancestors, where such stipendary donation was a mere supposition or figment, it carried abundance of hardship; and accordingly it was relieved by the charter of Henry I. which took this custody from the lord, and ordained that the custody, both of the land and the children, should belong to the widow or next of kin. But this noble immunity did not continue many years.

The wardship of the body was a consequence of the wardship of the land; for he who enjoyed the infant's estate was the properest person to educate and maintain him in his infancy: and also in a political view, the lord was most concerned to give his tenant a suitable education, in order to qualify him the better to perform those services which in his maturity he was bound to render.

When the male heir arrived at the age of 21, or the heir female at that of 16, they might sue out their livery or *ousterlemain*; that is the delivery of their lands

out-

Wardship ‖ Warn. out of their guardian's hands. For this they were obliged to pay a fine, namely, half-a-year's profits of the land; though this seems expressly contrary to *magna charta*. However, in consideration of their lands having been so long in ward, they were excused all reliefs, and the king's tenants also all primer seisins. In order to ascertain the profits that arose to the crown by these fruits of tenure, and to grant the heir his livery, the itinerant justices, or justices in eyre, had it formerly in charge to make inquisition concerning them by a jury of the county, commonly called an *inquisitio post mortem;* which was instituted to inquire (at the death of any man of fortune) the value of his estate, the tenure by which it was holden, and who, and of what age, his heir was; thereby to ascertain the relief and value of the primer seisin, or the wardship and livery accruing to the king thereupon. A manner of proceeding that came in process of time to be greatly abused, and at length an intolerable grievance; it being one of the principal accusations against Empson and Dudley, the wicked engines of Henry VII. that by colour of false inquisitions they compelled many persons to sue out livery from the crown, who by no means were tenants thereunto. And afterwards a court of wards and liveries was erected, for conducting the same inquiries in a more solemn and legal manner.

When the heir thus came of full age, provided he held a knight's fee, he was to receive the order of knighthood, and was compelled to take it upon him, or else pay a fine to the king. For in those heroical times no person was qualified for deeds of arms and chivalry who had not received this order, which was conferred with much preparation and solemnity. We may plainly discover the footsteps of a similar custom in what Tacitus relates of the Germans, who, in order to qualify their young men to bear arms, presented them in a full assembly with a shield and lance; which ceremony is supposed to have been the original of the feodal knighthood. This prerogative, of compelling the vassals to be knighted, or to pay a fine, was expressly recognised in parliament by the statute *de militibus*, 1 Edw. II.; was exerted as an expedient for raising money by many of our best princes, particularly by Edw. VI. and Queen Elizabeth; but this was the occasion of heavy murmurs when exerted by Charles I.; among whose many misfortunes it was, that neither himself nor his people seemed able to distinguish between the arbitrary stretch and the legal exertion of prerogative. However, among the other concessions made by that unhappy prince before the fatal recourse to arms, he agreed to divest himself of this undoubted flower of the crown; and it was accordingly abolished by statute 16 Car. I. c. 20.

WARE, a town of Hertfordshire, with a market on Tuesdays, and a fair on the last Tuesday in April, and Tuesday before St Matthew's day (Sept. 21.) for horses and other cattle. It is a large, well frequented town, seated on the river Lea, 21 miles north of London, and contained 3369 inhabitants in 1811. It carries on a great trade in malt and corn, which they are continually sending in large quantities to London. E. Long. 0. 3. N. Lat. 51. 50.

WARN, in *Law*, is to summon a person to appear in a court of justice.

WARNING *of* TENANTS, in *Scots Law*. See LAW, N° clxvii. 16. Warning ‖ Warrant.

WARP, in the manufactures, a name for the threads, whether of silk, wool, linen, hemp, &c. that are extended lengthwise on the weaver's loom; and across which the workman, by means of his shuttle, passes the threads of the woof, to form a cloth, ribband, fustian, or the like.

WARP, a small rope employed occasionally to remove a ship from one place to another, in a port, road, or river. And hence,

To WARP, is to change the situation of a ship, by pulling her from one part of a harbour, &c. to some other, by means of warps, which are attached to buoys; to anchors sunk in the bottom; or to certain stations upon the shore, as posts, rings, trees, &c. The ship is accordingly drawn forwards to those stations, either by pulling on the warps by hand, or by the application of some purchase, as a tackle, windlass, or capstern, upon her deck.

When this operation is performed by the ship's lesser anchors, these machines, together with their warps, are carried out in the boats alternately towards the place where the ship is endeavouring to arrive: so that when she is drawn up close to one anchor, the other is carried out to a competent distance before her, and being sunk, serves to fix the other warp, by which she is farther advanced.

Warping is generally used when the sails are unbent, or when they cannot be successfully employed, which may either arise from the unfavourable state of the wind, the opposition of the tide, or the narrow limits of the channel.

WARRANDICE, in *Scots Law*. See LAW, N° cxliv. 11.

WARRANT, is a power and charge to a constable or other officer to apprehend a person accused of any crime. It may be issued in extraordinary cases by the privy council, or secretaries of state; but most commonly it is issued by justices of the peace. This they may do in any cases where they have a jurisdiction over the offence, in order to compel the person accused to appear before them; for it would be absurd to give them power to examine an offender, unless they had also power to compel him to attend and submit to such examination. And this extends to all treasons, felonies, and breaches of the peace; and also to all such offences as they have power to punish by statute. Before the granting of the warrant, it is fitting to examine upon oath the party requiring it, as well as to ascertain that there is a felony or other crime actually committed, without which no warrant should be granted; as also to prove the cause and probability of suspecting the party against whom the warrant is prayed. Blackst. Comment. vol. iv. p. 290.

This warrant ought to be under the hand and seal of the justice; should set forth the time and place of making, and the cause for which it is made; and should be directed to the constable or other peace officer, or it may be to any private person by name. A general warrant to apprehend all persons suspected, without naming or particularly describing any person in special, is illegal and void for its uncertainty; for it is the duty of the magistrate, and ought not to be left to the officer, to judge of the ground of suspicion. Also a warrant to apprehend

prehend all persons guilty of such a crime, is no legal warrant; for the point upon which its authority rests, is a fact to be decided on a subsequent trial; namely, whether the person apprehended thereupon be guilty or not guilty. When a warrant is received by the officer, he is bound to execute it, so far as the jurisdiction of the magistrate and himself extends. A warrant from any of the justices of the court of king's bench extends over all the kingdom, and is tested or dated *England:* but a warrant of a justice of the peace in one county, must be backed, that is, signed, by a justice of another county, before it can be executed there. And a warrant for apprehending an English or a Scotch offender, may be indorsed in the opposite kingdom, and the offender carried back to that part of the united kingdom in which the offence was committed.

WARRANTY, Warrantia, in *Law*, a promise, or covenant by deed, made by the bargainer for himself and his heirs, to warrant and secure the bargainee and his heirs, against all men, for enjoying the thing agreed on or granted between them.

WARREN, Sir Peter, an admiral, distinguished by his virtue, learning, and undaunted courage, was descended from an ancient family in Ireland, and received a suitable education to qualify him for a command in the royal navy, in which he served for several years with great reputation; but the transaction which placed his great abilities in their full light, was the taking of Louisbourg in the year 1745, when he was appointed commodore of the British squadron sent on that service. He joined the fleet of transports from Boston in Canso bay on the 25th of April, having under his command the Superb of 60, and the Launceston and Eltham of 40 guns; he was afterwards joined by several other men of war sent from England, and took possession of Louisbourg on the 17th of June. The French, exasperated at this loss, were constantly on the watch to retake it; and in 1747 fitted out a large fleet for that purpose, and at the same time another squadron to prosecute their success in the East Indies. These squadrons sailed at the same time; but the views of the French were rendered abortive by the gallant Admiral Anson and Sir Peter Warren, who had been created rear-admiral, who with a large fleet of ships fell in with the French, defeated the whole fleet, and took the greatest part of the men of war. This was the last service Sir Peter rendered to his country as a commander in the British fleet; for a peace being concluded in the succeeding year, the fleet was laid up in the several harbours.

He was now chosen one of the representatives in parliament for Westminster; and in the midst of his popularity he paid a visit to Ireland, his native country, where he died of an inflammatory fever in 1752, sincerely lamented by all ranks of people; and an elegant monument of white marble was erected to his memory in Westminster abbey.

Warren, is a franchise or place privileged by prescription or grant from the king, for the keeping of beasts and fowls of the warren; which are hares and coneys, partridges, pheasants, and some add quails, woodcocks, and water-fowl, &c. These being *feræ naturæ*, every one had a natural right to kill as he could: but upon the introduction of the forest laws at the Norman conquest, these animals being looked upon as royal game, and the sole property of our savage monarchs, this franchise of free-warren was invented to protect them, by giving the grantee a sole and exclusive power of killing such game, so far as his warren extended, on condition of his preventing other persons. A man therefore that has the franchise of warren, is in reality no more than a royal game-keeper: but no man, not even a lord of a manor, could by common law justify sporting on another's soil, or even on his own, unless he had the liberty of free-warren. This franchise is almost fallen into disregard since the new statutes for preserving the game; the name being now chiefly preserved in grounds that are set apart for breeding hares and rabbits. There are many instances of keen sportsmen in ancient times, who have sold their estates, and reserved the free-warren, or right of killing game, to themselves: by which means it comes to pass that a man and his heirs have sometimes free-warren over another's ground.

A warren may lie open; and there is no necessity of inclosing it as there is of a park. If any person offend in a free warren, he is punishable by the common law, and by statute 21 Edw. III. And if any one enter wrongfully into any warren, and chase, take, or kill, any coneys without the consent of the owner, he shall forfeit treble damage, and suffer three months imprisonment, &c. by 22 and 23 Car. II. c. 25. When coneys are on the soil of the party, he hath a property in them by reason of the possession, and action lies for killing them; but if they run out of the warren and eat up a neighbour's corn, the owner of the land may kill them, and no action will lie.

WARSAW, a large city, capital of the province of Masovia, and of the ancient, as well as the revived kingdom of Poland. It is built partly in a plain, and partly on a gentle ascent rising from the banks of the Vistula, which is about as broad as the Thames at Westminster, but very shallow in summer. This city and its suburbs occupy a vast extent of ground, and contained in 1797, 70,000 inhabitants, among whom is a great number of foreigners. The whole has a melancholy appearance, exhibiting the strong contrast of wealth and poverty, luxury and distress. The streets are spacious, but ill paved; the churches and public buildings, and the palaces of the nobility are numerous and splendid; but the greatest part of the houses are mean and ill constructed wooden hovels.—At the final division of Poland in 1795, Warsaw fell to the share of Prussia, but was ceded by her to Bonaparte at the peace of Tilsit 1807; and on the overthrow of the French power, was assigned to Russia, with the territory named the duchy of Warsaw, which has since taken the name of the kingdom of Poland. E. Long. 21. 6. N. Lat. 52. 14.

WARWICK, the capital of Warwickshire in England, and from which this county derives its name. It is very ancient, and supposed by Camden to be the place called by the Romans *Præsidium*, where the Dalmatian horse were posted. It stands on a rock of freestone, of which all the public edifices in the town are built. At the Norman invasion it was a considerable place; and had many burgesses, of whom 12 were obliged by their tenure to accompany the king in his wars. It is supplied with water brought in pipes from springs half a mile from the town, besides what it derives from the wells within it made in the rock: and it is easily kept clean, by being situated upon a declivity. Four streets, from the four cardinal points of the compass, meet in the centre of the town. The principal public buildings are

St

Warwick, Warwickshire.

St Mary's, a very stately edifice, an hospital, a town-house of freestone, three charity schools, and a noble bridge over the Avon. It has had several charters; but is governed at present by a mayor, 12 brethren, 24 burgesses, &c. It contained 6497 inhabitants in 1811; and gives title of earl to the family of the Grevilles. W. Long. 1. 36. N. Lat. 52. 20.

WARWICKSHIRE, a county of England, 47 miles in length, by 30 in breadth. It is bounded at its northern extremity by a point of Derbyshire; on the north-west by Staffordshire; on the north-east by Leicestershire; on the east by Northamptonshire; on the south-west by Gloucestershire, and on the south-east by Oxfordshire. It is situated partly in the diocese of Litchfield and Coventry, and partly in that of Worcester; it contains four hundreds, and one liberty, one city, 12 market towns, 158 parishes; sends six members to parliament, and the population in 1811 amounted to 228,735. The air is mild, pleasant, and healthy. The river Avon divides the north part of it, or the Woodlands, from the south, called the Feldon; and the soil of both is rich and fertile. Its productions are corn, malt, wood, wool, cheese, coal, iron, and limestone. The chief rivers of this county are the Avon, Tame, and Arrow. Warwick is the capital; but Birmingham is far superior to it in respect of trade and manufactures, and even to any other town in England.

Birmingham, in this county, of which the account given in the order of the alphabet is very deficient, is one of the most remarkable towns in England, or perhaps in Europe, for the extent, variety, elegance, and utility of its manufactures. This town was little distinguished previous to the reign of Charles II. but since that period it continued to increase in extent and importance. In the year 1700, the number of streets in Birmingham was only 30; they are now nearly 250. In the year 1779 there were only three houses on a particular spot, which in 1791 contained 833.

Birmingham owes its prosperity and population to its manufactures, which are in a great measure the consequence of its vicinity to coal, aided by the spirited and industrious exertions of a few individuals. It has been stated, and no doubt with great truth, that its prosperity is in no small degree indebted to its exemption from the restrictions of borough and corporate laws. To give some notion of the progress and extent of the manufactures of this place, it may be mentioned that the late Mr Taylor, who introducted gilt buttons, japanned, gilt, and painted snuff-boxes, with various articles of manufacture in enamel, died in 1775, at the age of 64, having amassed a fortune of 200,000l. In painting snuff-boxes at so low a rate as one farthing each, one man could gain 3l. 10s. per week. The weekly produce of Mr Taylor's manufacture of buttons amounted to 800l. beside many other valuable and curious productions.

The manufactory of Messrs Boulton and Watt, which for its extent, variety, and importance, stands unrivalled in Europe, has been already noticed under the word SOHO. The new coinage of copper, which is so often deservedly admired, and the re-stamped dollars, are the productions of the Soho manufactory. The first coining mill was erected at Soho in 1783. It is now so much improved, that eight machines driven by the steam engine, are going on at the same time. Each of those machines strikes from 70 to 84 pieces of the size of a guinea per minute, and hence the whole eight machines work off in one hour between 30,000 and 40,000 coins. The different processes of the machinery are, 1. Rolling the masses of copper into sheets. 2. Rolling them through cylindrical steel rollers. 3. Clipping the pieces of copper for the dye. 4. Shaking the coin in bags. 5. Striking both sides of the coin, and then milling it; after which it is displaced, and another is introduced, to be subjected to the same operation. But the most extraordinary contrivance of this ingenious machinery is, that a precise account of every coin which passes through it is regularly kept, so that it is impossible to practise fraud.

5

Warwickshire, Washing.

Beside the branches of industry already mentioned, there are manufactories of guns, bayonets, and swords, of sporting guns, of whips, of japan ware, of numerous works in brass and steel, both for ornament and use, and at one time of leather to a considerable extent.

Birmingham contains a museum of natural and artificial curiosities, a handsome theatre, rebuilt since 1791, several churches belonging to the establishment, various dissenting meeting houses, and a number of charitable establishments. By means of canals Birmingham has the advantage of easy communication with almost every part of the kingdom. See WARWICKSHIRE, SUPPLEMENT.

WASH, among distillers, the fermentable liquor used by malt distillers. See BREWERY.

WASHING, in *Painting*, is when a design, drawn with a pen or crayon, has some one colour laid over it with a pencil, as Indian ink, bistre, or the like, to make it appear the more natural, by adding the shadow of prominences, apertures, &c. and by imitating the particular matters whereof the thing is supposed to consist.

Thus a pale red is employed to imitate brick and tile; a pale Indian blue, to imitate water and slate; green, for trees and meadows; saffron or French berries, for gold or brass; and several colours for marbles.

WASHING of Ores, the separation of the ores of metals, by means of water, from earths and stones, which would otherwise render it difficult of fusion. See ORES, *Reduction of*.

WASHINGTON, a city of North America, and now the metropolis of the United States. It is seated at the junction of the rivers Potomac and the Eastern Branch, extending about four miles up each, including a tract of territory scarcely to be exceeded, in point of convenience, salubrity, and beauty, by any in the world. This territory, which is called *Columbia*, lies partly in Virginia, and partly in Maryland, and was ceded by those two states to the Republic; it was placed under the immediate government of Congress, and established as the seat of government in the year 1800. It is divided into squares or grand divisions, by streets running due north and south, and east and west, which form the ground-work of the plan. However, from the Capitol, the president's house, and some of the important areas in the city, run diagonal streets, from one material object to another, which not only produce a variety of charming prospects, but remove the insipid sameness which renders some other great cities unpleasing. The great leading streets are all 160 feet wide, including a pavement of 10 feet, and a gravel walk of 30 feet planted with trees on each side, which will leave 80 feet of paved street for carriages. The rest of the streets are in general

Washington.

general 110 feet wide, with a few only 90 feet, except North, South, and East Capitol Streets, which are 160 feet. The diagonal streets are named after the respective states composing the Union, while those running north and south are, from the Capitol eastward, named *East First Street, East Second Street*, &c. The squares or divisions of the city amount to 1150. The rectangular squares generally contain from three to six acres, and are divided into lots of from 40 to 80 feet in front, and their depth from about 110 to 300 feet, according to the size of the square. All the houses must be of brick or stone. The Capitol (or house for the legislative bodies) is situated upon the most beautiful eminence in the city, about a mile from the Eastern Branch, and not much more from the Potomac, commanding a full view of every part of the city, as well as a considerable extent of the country around. It is not yet finished (1818), but is allowed to be a magnificent structure. Its front extends 650 feet in length, with a colonnade of 260 feet. The height of the dome is 150 feet. The president's house stands upon a rising ground, not far from the banks of the Potomac, possessing also a delightful prospect. By the Potomac, vessels of considerable burden come out to Washington; and, by means of short canals at the falls, this river with its branches is open for some hundred miles above the town to boat navigation. Washington, however, has not advanced so rapidly as was expected. In 1818, according to Mr Fearon, it contained only about 9000 inhabitants, or 15,000, including Georgetown. The lines which have received the name of streets, are in general only marked by a slight trace, or by rows of poplars; and altogether it presents the appearance of straggling houses irregularly scattered over an open field.

In 1814 Washington was taken by a British force of 6500 men; who abandoned the town the following day, after having set fire to the capitol, president's house, navy-yard, and wooden-bridge over the river. The loss sustained by the Americans in the buccaneering expedition was estimated at 1,031,000 dollars.

WASHINGTON, *George*, the celebrated commander of the American army, and the first president of the United States, after their separation from the mother-country, was born in the year 1732, in the parish of Washington in Virginia. He was descended from an ancient family in Cheshire, of which a branch was established in Virginia about the middle of the 17th century. Little is known concerning his education, or the early years of his life. Before he was 20 years of age, he was appointed a major in the colonial militia, and had then an opportunity of displaying those military and political talents which have since rendered his name so famous throughout the world. In the disputes which arose between the French and English officers, about settling the limits of Canada and Louisiana, Major Washington was employed by the governor of Virginia as a negociator, and he succeeded in preventing a threatened invasion of the English frontiers by the French and their Indian allies; but, in the following year, when hostilities seemed inevitable, he was appointed lieutenant-colonel, and soon after to the command of a regiment raised by the colony for its own defence. In 1755, Colonel Washington served as a volunteer in the unfortunate expedition of General Braddock, and in that expedition, which was attended with great difficulty, he exhibited so much calmness and intrepidity, that the utmost confidence was reposed in his talents, and perfect obedience paid to his commands by the whole army. After having been employed in a different and more successful expedition, to the river Ohio, the state of his health required him, about the year 1758, to resign his military situation; and in the sixteen following years, during which period he married Mrs Custis, a Virginian lady, of amiable character and respectable connections, it would appear that he resided chiefly at his beautiful seat of Mount Vernon, and was occupied in the cultivation of his estate.

When the disaffection of the Americans to the British government had become pretty general, and had at last spread to the colony of Virginia, Colonel Washington was appointed a delegate from that state to the congress which met at Philadelphia on the 26th October 1774, and soon after he was appointed to the command of the American army, which had assembled in the provinces of New England. The conduct of Washington during the whole of the war, as well as during the period that he presided in the government of the United States, has been so fully detailed in another part of this work, that it would be unnecessary repetition, even to give a general outline of it in this place. See AMERICA.

Washington resigned the presidency in 1796, after having published a farewell address to his countrymen. This address was remarkably distinguished for the simplicity and ingenuousness, moderation and sobriety, the good sense, prudence and honesty, as well as sincere affection for his country and for mankind, which the author of it had always exhibited; it seemed to be a perfect picture of his whole life. From the time of his resignation till the month of July 1798, he lived in retirement at his seat of Mount Vernon. At this period, when the unprincipled actors in the French revolution were carrying on their wicked machinations in every part of the world to which their influence extended, the United States resolved to arm by land and sea in their own defence. General Washington was called from his retirement, and the command of the army was bestowed upon him. This he accepted, because he considered, as he himself expressed it, "every thing we hold dear and sacred was seriously threatened, although he had flattered himself that he had quitted for ever the boundless field of public action, incessant trouble, and high responsibility, in which he had long acted so conspicuous a part." In this situation he continued during the remaining short period of his life. On Thursday the 12th of December 1799, he was seized with an inflammation in the throat, and was carried off on Saturday the 14th of the same month, in the 68th year of his age. In his dying moments he displayed the same calmness, simplicity, and regularity, which had uniformly marked his conduct through life. He saw the approaches of death without fear; and he met them without parade. Even the perfectly well ordered state of the minutest particulars of his private business bears the stamp of that constant authority of prudence and practical reason over his actions which was always the most prominent feature of his character.

WASHINGTON is the name of many counties, towns, and villages in the American states; a circumstance which affords a striking proof in what degree of esteem

Washington || Watch.

and veneration the name from which they are derived was held by the inhabitants of the new world.

WASP. See VESPA, ENTOMOLOGY *Index*.

WATCH, in the art of war, a number of men posted at any passage, or a company of the guards who go on the patrole.

WATCH, in the navy, the space of time wherein one division of a ship's crew remains upon deck, to perform the necessary services, whilst the rest are relieved from duty, either when the vessel is under sail or at anchor.

The length of the sea-watch is not equal in the shipping of different nations. It is always kept four hours by our British seamen, if we except the dog-watch, between four and eight in the evening, that contains two reliefs, each of which are only two hours on deck. The intent of this is to change the period of the night-watch every 24 hours; so that the party watching from eight till 12 in one night, shall watch from midnight till four in the morning on the succeeding one. In France the duration of the watch is extremely different, being in some places six hours, and in others seven or eight; and in Turkey and Barbary it is usually five or six hours.

A ship's company is usually classed into two parties; one of which is called the *starboard* and the other the *larboard* watch. It is, however, occasionally separated into three divisions, as in a road or in particular voyages.

In a ship of war the watch is generally commanded by a lieutenant, and in merchant ships by one of the mates; so that if there are four mates in the latter, there are two in each watch; the first and third being in the larboard, and the second and fourth in the starboard watch: but in the navy, the officers who command the watch usually divide themselves into three parties, in order to lighten their duty.

WATCH, is also used for a small portable movement, or machine, for the measuring of time; having its motion regulated by a spiral spring.

Watches, strictly taken, are all such movements as show the parts of time; as clocks are such as publish it, by striking on a bell, &c. But commonly the name *watch* is appropriated to such as are carried in the pocket; and *clock* to the large movements, whether they strike the hour or not. See CLOCK.

The invention of spring or pocket watches belongs to the present age. It is true, we find mention made of a watch presented to Charles V. in the history of that prince: but this, in all probability, was no more than a kind of clock to be set on a table, some resemblance whereof we have still remaining in the ancient pieces made before the year 1670. There was also a story of a watch having been discovered in Scotland belonging to King Robert Bruce; but this we believe has turned out altogether apocryphal. The glory of this very useful invention lies between Dr Hooke and M. Huygens; but to which of them it properly belongs, has been greatly disputed; the English ascribing it to the former, and the French, Dutch, &c. to the latter. Mr Derham in his Artificial Clockmaker, says roundly, that Dr Hooke was the inventor; and adds, that he contrived various ways of regulation. One way was with a loadstone: Another with a tender straight spring, one end whereof played backwards and forwards with the balance; so that the balance was to the spring as the bob to a pendulum, and the spring as the rod thereof: A third method was with two balances, of which there were divers sorts; some having a spiral spring to the balance for a regulator, and others without. But the way that prevailed, and which continues in mode, was with one balance, and one spring running round the upper part of the verge thereof: Though this has a disadvantage, which those with two springs, &c. were free from; in that a sudden jerk, or confused shake, will alter its vibrations, and put it in an unusual hurry.

The time of these inventions was about the year 1658; as appears among other evidences, from an inscription on one of the double balance watches presented to King Charles II. viz. Rob. Hooke *inven.* 1658. T. Tompion *fecit*, 1675. The invention presently got into reputation, both at home and abroad; and two of them were sent for by the dauphin of France. Soon after this M. Huygens's watch with a spiral spring got abroad, and made a great noise in England, as if the longitude could be found by it. It is certain, however, that his invention was later than the year 1673, when his book *de Horol. Oscillat.* was published; wherein he has not one word of this, though he has of several other contrivances in the same way.

One of these the lord Brouncker sent for out of France, where M. Huygens had got a patent for them. This watch agreed with Dr Hooke's in the application of the spring to the balance; only M. Huygens's had a longer spiral spring, and the pulses and beats were much slower. The balance, instead of turning quite round, as Dr Hooke's, turns several rounds every vibration.

Mr Derham suggests, that he has reason to doubt M. Huygens's fancy first was set to work by some intelligence he might have of Dr Hooke's invention from Mr Oldenburgh, or some other of his correspondents in England; and this, notwithstanding Mr Oldenburgh's attempt to vindicate himself in the Philosophical Transactions, appears to be the truth. Huygens invented divers other kinds of watches, some of them without any string or chain at all; which he called, particularly, *pendulum watches.*

Striking WATCHES are such as, besides the proper watch-part for measuring of time, have a clock part for striking the hours, &c.

Repeating WATCHES, are such as by pulling a string, &c. repeat the hour, quarter, or minute, at any time of the day or night.—This repetition was the invention of Mr Barlow, and first put in practice by him in larger movements or clocks about the year 1676. The contrivance immediately set the other artists to work, who soon contrived divers ways of effecting the same. But its application to pocket-watches was not known before King James II.'s reign; when the ingenious inventor above mentioned, having directed Mr Thompson to make a repeating watch, was soliciting a patent for the same. The talk of a patent engaged Mr Quare to resume the thoughts of a like contrivance, which he had had in view some years before: he now effected it; and being pressed to endeavour to prevent Mr Barlow's patent, a watch of each kind was produced before the King and council; upon trial of which, the preference was given to Mr Quare's. The difference between them was, that Barlow's was made to repeat by pushing in two pieces on each side the watch-box; one of which repeated the hour, and the other the quarter: whereas Quare's was made to repeat by a pin that struck out near the pendant, which being thrust in (as now

Watch.

now it is done by thrusting in the pendant itself), repeated both the hour and quarter with the same thrust.

Of the Mechanism of a WATCH, properly so called. Watches, as well as clocks, are composed of wheels and pinions, and a regulator to direct the quickness or slowness of the wheels, and of a spring which communicates motion to the whole machine. But the regulator and spring of a watch are vastly inferior to the weight and pendulum of a clock, neither of which can be employed in watches. In place of a pendulum, therefore, we are obliged to use a balance (fig. 1.) to regulate the motion of a watch; and a spring (fig. 2.) which serves in place of a weight, to give motion to the wheels and balance.

Plate DLXXI. Fig. 1. Fig. 2.

The wheels of a watch, like those of a clock, are placed in a frame formed of two plates and four pillars. Fig. 3. represents the inside of a watch, after the plate (fig. 4.) is taken off. A is the barrel which contains the spring (fig. 2.); the chain is rolled about the barrel, with one end of it fixed to the barrel A (fig. 5.), and the other to the fusee B.

Fig. 3. Fig. 4. Fig. 5.

When a watch is wound up, the chain which was upon the barrel winds about the fusee, and by this means the spring is stretched; for the interior end of the spring is fixed by a hook to the immoveable axis, about which the barrel revolves; the exterior end of the spring is fixed to the inside of the barrel, which turns upon an axis. It is therefore easy to perceive how the spring extends itself, and how its elasticity forces the barrel to turn round, and consequently obliges the chain which is upon the fusee to unfold and turn the fusee; the motion of the fusee is communicated to the wheel C (fig. 5.); then, by means of the teeth, to the pinion *c*, which carries the wheel D; then to the piston *d*, which carries the wheel E: then to the pinion *e*, which carries the wheel F; then to the point *f*, upon which is the balance-wheel G, whose pivot runs in the pieces A called the *potance*, and B called a *follower*, which are fixed on the plate fig. 4. This plate, of which only a part is represented, is applied to that of fig. 3. in such a manner that the pivots of the wheels enter into holes made in the plate fig. 3. Thus the impressed force of the spring is communicated to the wheels: and the pinion *f* being then connected to the wheel F, obliges it to turn (fig. 5.). This wheel acts upon the palettes of the verge, 1, 2, (fig. 1.), the axis of which carries the balance HH, (fig. 1.). The pivot I, in the end of the verge, enters into the hole *c* in the potance A (fig. 4.). In this figure the palettes are represented; but the balance is on the other side of the plates, as may be seen in fig. 6. The pivot 3 of the balance enters into a hole of the cock BC (fig. 7.), a perspective view of which is represented in fig. 8. Thus the balance turns between the cock and the potance *c* (fig. 4.), as in a kind of cage. The action of the balance wheel upon the palettes 1, 2, (fig. 1.), is the same with what we have described with regard to the same wheel in the clock; *i. e.* in a watch, the balance-wheel obliges the balance to vibrate backwards and forwards like a pendulum. At each vibration of the balance a palette allows a tooth of the balance-wheel to escape; so that the quickness of the motion of the wheels is entirely determined by the quickness of the vibrations of the balance; and these vibrations of the balance and motion of the wheels are produced by the action of the spring.

Fig. 6. Fig. 7. Fig. 8.

But the quickness or slowness of the vibrations of the balance depend not solely upon the action of the great spring, but chiefly upon the action of the spring *a*, *b*, *c*, called *the spiral spring* (fig. 9.), situated under the balance H, and represented in perspective (fig. 6.). The exterior end of the spiral is fixed to the pin *a*, (fig. 9.). This pin is applied near the plate in *a*, (fig. 6.); the interior end of the spiral is fixed by a peg to the centre of the balance. Hence if the balance is turned upon itself, the plates remaining immoveable, the spring will extend itself, and make the balance perform one revolution. Now, after the spiral is thus extended, if the balance be left to itself, the elasticity of the spiral will bring back the balance, and in this manner the alternate vibrations of the balance are produced.

Fig. 9.

In fig. 5. all the wheels above described are represented in such a manner, that you may easily perceive at first sight how the motion is communicated from the barrel to the balance.

In fig. 10. are represented the wheels under the dial-plate by which the hands are moved. The pinion *a* is adjusted to the force of the prolonged pivot of the wheel D (fig. 5.), and is called a *cannon pinion*. This wheel revolves in an hour. The end of the axis of the pinion *a*, upon which the minute-hand is fixed, is square; the pinion (fig. 10.) is indented into the wheel *b*, which is carried by the pinion *a*. Fig. 11. is a wheel fixed upon a barrel, into the cavity of which the pinion *a* enters, and upon which it turns freely. This wheel revolves in 12 hours, and carries along with it the hour-hand. For a full account of the principles upon which watches and all time-keepers are constructed, we must refer our readers to a short treatise, entitled *Thoughts on the Means of improving Watches*, by Thomas Mudge.

Fig. 10. Fig. 11.

WATCH-Glasses, in a ship, are glasses employed to measure the period of the watch, or to divide it into any number of equal parts, as hours, half-hours, &c. so that the several stations therein may be regularly kept and relieved, as at the helm, pump, look-out, &c.

WATCH-Work. There is one part of the movements of clocks and watches of which we have yet given no particular account. This is the method of applying the maintaining power of the wheels to the regulator of the motions, so as not to injure its power of regulation. This part of the construction is called SCAPEMENT, and falls to be described under the present article, to which we have referred from SCAPEMENT.

1 Objects of scapements.

The motions of a clock or watch are regulated by a pendulum or balance, without which check the wheels impelled by the weight in the clock, or spring in the watch, would run round with a rapidly accelerating motion, till this should be rendered uniform by friction, and the resistance of the air. If, however, a pendulum or balance be put in the way of this motion, in such a manner that only one tooth of a wheel can pass, the revolution of the wheels will depend on the vibration of the pendulum or balance.

We cannot here enter on an historical account of the improvements that have been made on the regulating powers of clocks and watches, nor can we detail the principles on which their action depends. It will be sufficient here to notice the most simple construction of scapements, and then to describe two or three of the most improved constructions that have been applied to time-keepers.

We know that the motion of a pendulum or balance

Watch.

is alternate, while the pressure of the wheels is constantly exerted in the same direction. Hence it is evident that some means must be employed to accommodate these different motions to each other. Now, when a tooth of the wheel has given the pendulum or balance a motion in one direction, it must quit it, that the pendulum or balance may receive an impulsion in the opposite direction. This *escape* of the tooth has given rise to the term *scapement*.

2
Best ordinary scapement for clocks.
Fig. 12.

The ordinary scapement is extremely simple, and may be thus illustrated. Let $x\,y$, fig. 12. Plate DLXXI. represent a horizontal axis, to which the pendulum p is attached by a slender rod. This axis has two leaves c and d, one near each end, and not in the same plane, but so that when the pendulum hangs perpendicularly at rest, c spreads a few degrees to the right, and d as much to the left. These are called the pallets. Let $a\,f\,b$ represent a wheel, turning on a perpendicular axis $e\,o$ in the order $a\,f\,e\,b$. The teeth of this wheel are in the form of those of a saw, leaning forward in the direction of the rim's motion. This wheel is usually called the crown-wheel, or in watches the balance-wheel. See CLOCK and WATCH. It generally contains an odd number of teeth. In the figure the pendulum is represented at the extremity of its excursion towards the right, the tooth a having just escaped from the pallet c, and b having just dropt on d. Now it is evident that while the pendulum is moving to the left, in the arch $p\,g$, the tooth b still presses on the pallet d, and thus accelerates the pendulum, both in its descent along $p\,h$, and its ascent up $h\,g$, and that when d, by turning round the axis $x\,y$, raises its point above the plane of the wheel, the tooth b escapes from it, and i drops on c, now nearly perpendicular. Thus c is pressed to the right, and the motion of the pendulum along $g\,p$ is accelerated. Again, while the pendulum hangs perpendicularly in the line $x\,h$, the tooth b, by pressing on d, will force the pendulum to the left, in proportion to its lightness, and if it be not too heavy, will force it so far from the perpendicular, that b will escape, and i will catch on c, and force the pendulum back to p, when the same motion will be repeated. This effect will be more remarkable, if the rod of the pendulum be continued through $x\,y$, and have a ball q on the other end, to balance p. When b escapes from d, the balls are moving with a certain velocity and momentum, and in this condition the balance is checked when i catches on c. It is not, however, instantly stopped, but continues to move a little to the left, and i is forced a little backward by the pallet c. It cannot make its escape over the top of the tooth i, as all the momentum of the balance was generated by the force of b, and i is of equal power. Besides, when i catches on c, and the motion of c to the left continues, the lower point of c is applied to the face of i, which now acts on the balance by a long lever, soon stops its motion in that direction, and continuing to press on c, urges the balance in the opposite direction. It is easy to see that the motion of the wheel here must be hobbling and unequal, which has given to this scapement the name of the *recoiling* scapement.

3
Vibrations of pendulums are isochronous.

In considering the utility of the following improved scapement for clocks, we must keep in mind the following proposition, which, after the above illustration, scarcely requires any direct proof. It is, that the natural vibrations of a pendulum are *isochronous*, or are performed in equal times. The great object of the scapement is to preserve this isochronous motion of the pendulum.

4
Cumming's scapement for clocks.

As the defect of the recoiling scapement was long apparent, several ingenious artists attempted to substitute in its place a scapement that should produce a more regular and uniform motion. Of these, the scapement contrived by Mr Cumming appears to be one of the most ingenious in its construction, and most perfect in its operation. The following construction is similar to that of Mr Cumming, but rendered rather less complex for the purpose of shortening the description.

Fig. 13.

Let ABC, fig. 13. represent a portion of the swing wheel, of which O is the centre, and A one of the teeth; Z is the centre of the crutch, pallets, and pendulum. The crutch is represented of the form of the letter A, having in the circular cross piece a slit $i\,k$, also circular, Z being the centre. The arm ZF forms the first detent, and the tooth A is represented as locked on it at F. D is the first pallet on the end of the arm Zd moveable round the same centre with the detents, but independent of them. The arm $d\,e$ to which the pallet D is attached, lies wholly behind the arm ZF of the detent, being fixed to a round piece of brass $e\,f\,g$, having pivots turning concentric with the axis of the pendulum. To the same piece of brass is fixed the horizontal arm e H, carrying to its extremity the ball H, of such size, that the action of the tooth A on the pallet D is just able to raise it up to the position here drawn. ZPp represents the fork, or pendulum rod, behind both detent and pallet. A pin p projects forward, coming through the slit $i\,k$, without touching either margin of it. Attached to the fork is the arm $m\,n$, of such length that, when the pendulum rod is perpendicular, the angular distance of $n\,q$ from the rod $e\,q$ H is just equal to the angular distance of the left side of the pin p from the left end i of the slit $i\,k$.

Now, the natural position of the pallet D is at δ, represented by the dotted lines, resting on the back of the detent F. It is naturally brought into this position by its own weight, and still more by the weight of the ball H. The pallet D, being set on the foreside of the arm at Z, comes into the same plane with the detent F and the swing-wheel, though here represented in a different position. The tooth C of the wheel is supposed to have escaped from the second pallet, on which the tooth A immediately seizes the pallet D, situated at δ, forces it out, and then rests on the detent F, the pallet D leaning on the tip of the tooth. After the escape of C, the pendulum, moving down the arch of semivibration, is represented as having attained the vertical position. Proceeding still to the left, the pin p reaches the extremity i of the slit $i\,k$; and, at the same instant, the arm n touches the rod e H in q. The pendulum proceeding a hairsbreadth further, withdraws the detent F from the tooth, which now even pushes off the detent, by acting on the inclining face of it. The wheel being now unlocked, the tooth following C on the other side acts on its pallet, pushes it off, and rests on its detent, which has been rapidly brought into a proper position by the action of A on the inclining face of F. By a similar action of C on its detent at the moment of escape, F was brought into a position proper for the wheels being locked by the tooth A. As the pendulum still goes on, the ball H, and pallet connected with it, are carried by the arm $m\,n$, and before the pin p again reaches the end

Watch.

end of the slit, which had been suddenly withdrawn by the action of A on F, the pendulum comes to rest. It now returns towards the right, loaded with the ball H on the left, and thus the motion lost during the last vibration is restored. When the pin *p*, by its motion to the right, reaches the end *k* of *i k*, the wheel on the right side is unlocked, and at the same instant the weight H being raised from the pendulum by the action of a tooth like B on the pallet D, ceases to act.

In this scapement, both pallets and detents are detached from the pendulum, except in the moment of unlocking the wheel, so that, except during this short interval, the pendulum may be said to be free during its whole vibration, and of course its motion must be more equable and undisturbed.

5 Scapements for watches.

The constructing of a proper scapement for watches requires peculiar delicacy, owing to the small size of the machine, from which the error of $\frac{1}{100}$ of an inch has as much effect as the error of a whole inch in a common clock. From the necessary lightness of the balance, too, it is extremely difficult to accumulate a sufficient quantity of regulating power. This can be done only by giving the balance a great velocity, which is effected by concentrating as much as possible of its weight in the rim, and making its vibrations very wide. The balance rim of a tolerable watch should pass through at least ten inches in every second.

6 Vibrations of a balance are isochronous.

In considering the most proper scapements for watches, we may assume the following principle, viz. that the oscillations of a balance urged by its spring, and undisturbed by extraneous forces, are isochroneus.

7 Best ordinary scapement for watches. Fig. 14.

In ordinary pocket watches, the common recoiling scapement of clocks is still employed, and answers the common purposes of a watch tolerably well, so that, if properly executed, a good ordinary watch will keep time within a minute in the day. These watches, however, are subject to great variation in their rate of going, from any change in the power of the wheels.

The following is considered as the best construction of the common watch scapement, and is represented by fig. 14. as it appears when looking straight down on the end of the balance arbor. C marks the centre of the balance and verge; CA represents the upper pallet, or that next the balance, and CB the lower pallet; F and D are two teeth of the crown wheel, moving from left to right; E, G, are two teeth in the lower part, moving from right to left. The tooth D appears as having just escaped from the point of CA, and the tooth E as having just come in contact with CB. In practice, the scapement should not be quite so close, as by a small inequality of the teeth, D might be kept from escaping at all. The following are thought the best proportions: The distance between the front of the teeth (that is, of G, F, E, D), and the axis C of the balance, is $\frac{1}{4}$ of FA, the distance between the points of the teeth. The length CA, CB of the pallets is $\frac{1}{3}$ of the same degrees, and the front DH or FK of the teeth makes an angle of 25° with the axis of the crown wheel. The sloping side of the tooth must be of an epicycloidal form, suited to the relative motion of the tooth and pallet.

It appears from these proportions, that by the action of the tooth D, the pallet A can *throw out* till it reach *a*, 120° from CL, the line of the crown-wheel axis. To this if we add BCA=95°, we shall have LC *a*=120°. Again, B will throw out as far on the other side. Now, if from 240°, the sum of the extent of vibration of both pallets, we take 95° the angle of the pallets, the remainder 145° will express the greatest vibration which the balance can make, without striking the front of the teeth. From several causes, however, this measure is too great, and 120° is reckoned a sufficient vibration in the best ordinary scapement.

8 Graham's horizontal scapement. Fig. 15. and 16.

Of the improvements on the scapements of watches, one of the most important is that by Mr George Graham, which we shall proceed to describe. DE, fig. 15. represents part of the rim of the balance wheel; A and C, two of its teeth with their faces *b e* formed into planes, inclined to the circumference of the wheel in an angle of about 15°, so that the length *b e* of the face may be nearly quadruple of its height *e m*. Let a circular arch ABC be described round the centre of the wheel, and through the middle of the faces of the teeth. The axis of the balance will pass through some point B of this arch, and the mean circumference of the teeth may be said to pass through the centre of the verge. On this axis is fixed a portion of a thin hollow cylinder *bcd*, made of hard tempered steel, or of some hard and tough stone, such as ruby or sapphire. By this construction the portion of the cylinder occupies 210° of the circumference. The edge *b*, to which the tooth approaches from without, is rounded off on both angles. The other edge *d* is formed into a plane, inclined to the radius about 30°. Now, suppose the wheel pressed forward in the direction AC, the point *b* of the tooth, touching the rounded edge, will push it outwards, turning round the balance in the direction *b c d*. The heel *e* of the tooth will escape from this edge when it is in the position *h*, and *e* is in the position *f*. The point *b* of the tooth will now be at *d*, but the edge of the cylinder will be at *i*. The tooth therefore rests in the inside of the cylinder, while the balance continues its vibration a little way, in consequence of the impulse it has received from the action of the inclined plane. When this vibration is ended, by the opposition of the balance spring, the balance will return, and the tooth now in the position B, rubbing on the inside of the cylinder, the balance comes back into its natural position *b c d*, with an accelerated motion by the action of its spring, and would of itself vibrate as far as the other side. It is, however, assisted again by the tooth, which presses on the edge *d*, pushes it aside till it attain the position *k*, when the tooth entirely escapes from the cylinder. At this instant the other edge of the cylinder, having attained the position *l*, is in the way of the next tooth, which is now in the position A, while the balance continues its vibration, the tooth resting and rubbing on the outside of the cylinder. When this vibration is finished, the balance, by the action of the spring, resumes its first motion, and as soon as the balance gets into its natural position, the tooth begins to act on the edge *b*, pushes it aside, escapes from it, and drops as before in the inside of the cylinder. In this construction the arch of action or scapement is 30°= twice the angle which the face of a tooth makes with the circumference.

It is necessary to explain how the cylinder is connected with the verge, so as to make such a great revolution round the tooth of the wheel. The triangular tooth *e b m* is placed on the top of a little pillar fixed into the end of the piece of brass *m* D formed in the rim of the wheel. Thus the plane of the wedge tooth is parallel

Watch. rallel to the plane of the wheel, but at a small distance above it. The verge is represented at fig. 16. and consists of a long hollow cylinder of cast steel, having a great portion of the metal cut out. If spread out flat, this cylinder would assume the form of fig. 17.; and if we conceive this flat piece rolled up till the edges GH and G′ H′ unite, we shall have the exact form. The part acted on by the point of the tooth is denoted by the dotted line *b d*, and the part D, I, F, E serves to connect the two ends.

This scapement of Mr Graham is called a *horizontal* scapement, because the balance is parallel to the other wheels.

9 Lepaute's improvement. Fig. 18. and 19.

Another scapement of a superior construction was contrived by M. Lepaute of Paris, and is of such a singular form as to render it extremely difficult to illustrate it by a figure. The representations at fig. 18. and 19. will, however, give general readers some idea of its mode of action, and a skilful artist will easily see how the several parts may be adapted to each other. ABC fig. 18. represents part of the rim of the balance wheel, having the pins 1, 2, 3, 4, 5, &c. projecting from its faces; the pins 1, 3, 5, being on the side next the eye, and the pins 2 and 4 on the opposite side. D is the centre of the balance and verge, and the small circle round D represents its thickness. But the verge in this place is crooked, that the rim of the wheel may not be intercepted by it. To it is attached a piece of hard tempered steel *a b c d*, of which the part *a b c* is a concave arch of a circle, having D for its centre. It wants about 30° of a semicircle. The rest *c d* is also an arch of a circle having the rame radius with the balance-wheel. In the natural position of the balance, a line drawn from D, through the middle of the face *c d* is a tangent to the circumference of the wheel. But if the balance be turned round till the point *d* of the horn come to *d′*, and the point *c* come to 2 in the circumference in which the pins are placed, the pin pressing on the beginning of the horn or pallet, pushes it aside, slides along it, and escapes at *d*, having generated a certain velocity in the balance. Let another pallet similar to that now described be placed on the other side of the wheel, but in a contrary position, with the acting face of the pallet turned away from the centre of the wheel. Let it be so placed at E, that the moment the pin 1 on the upper side of the wheel escapes from the pallet *c d*, the pin 4 on the lower side of the wheel falls on the end of the circular arch *e f g* of the other pallet. Now, if the pallets be connected by equal pulleys G and F on the axis of each, and a thread round both so that they shall turn one way; the balance on the axis D having received an impulse from the pin 1, will continue its motion from A towards *i*, and will carry the other pallet with a similar motion round the centre E from *h* to *k*. The pin 4 will therefore rest in the concave arch *g f e* as the pallet turns round. When the force of the balance is spent, the pallet *c d* returns towards its first position. The pallet *g h* turns with it, and when the point of the first has arrived at *d*, the beginning *g* of the other arrives at the pin 4; and, proceeding farther, this pin escapes from the concave arch *e f g*, and slides along the pallet *g h*, pushing it aside, and of course urging the pallet round the centre E, and the balance on the axis D round at the same time, and in the same direction. The pin 4 escapes from the pallet *g h*, when *h* arrives at 3; but while the pin 4 is sliding along the yielding pallet *g h*, the pin 3 is moving in the circumference BDA; and the instant that the pin 4 escapes from *h* at 3, the pin 3 arrives at 2, where the beginning *c* of the concave arch *c b* is ready to receive it. It therefore rests on this arch, while the balance continues its motion, and this may continue till the point *b* of the arch comes to 2. The balance now stops, its force being spent, and then returns; and the pin 3 escapes from the circle at *c*, slides along the yielding pallet *c d*, and when it escapes at 1, another pin on the lower side of the wheel arrives at 4, and finds the arch *g f e* ready to receive it. And thus the vibration of the balance will be continued.

From the above description we may deduce the proper dimensions of the parts of the pallet. Thus, the length of the pallet *c d* or *g h*, must be equal to the interval between two succeeding pins, and the distance of the centres DE, must be double of that interval. The radius D *e* or F *g*, may be as small as we choose. The concave arches *c b a* and *g f e*, must be continued so far as to allow a pin to rest on them during the whole excursion of the balance. The angle of scapement, in which the balance remains under the influence of the wheels, is obtained by drawing the lines D *c* and D *d*, and we shall find that this angle *c* D *d* is here about 30°, though it may be made either greater or less than this.

Fig. 19. Fig. 19. explains how the two pallets may be combined on one verge. KL is the verge with a pivot at each end. It is bent like a crank MNO, to admit the balance wheel between its branches. BC represents this wheel, seen edgewise, with its pin alternately on different sides. The pallets are also represented by *b c d* and *h g f*, sized to the inside of the branches of the crank, fronting each other. The position of their acting faces may be seen in the preceding figure, on the verge D, where the pallet *g h* is represented by the dotted line 2 *i′*, as situated behind the pallet *c d*. The remote pallet 2 *i* is so placed, that when the point *d* of the near pallet is quitted by a pin 1 on the upper side of the wheel, the angle formed by the face and the arch of rest of the other pallet is just ready to receive the next pin 2, which lies on the lower side of the rim. It is plain that the action here will be the same as if the pallets were on separate axes. The pin 1 escapes from *d*, and the pin 2 is received on the arch of rest, and locks the wheel, while the balance continues in motion. When the balance returns, 2 gets off the arch of rest, pushes aside the pallet 2 *i*, escapes from it when *i* gets to 1, and then the point *c* is ready to receive the pin 3, &c. The vibrations may be increased by giving a sufficient impulse through the angle of scapement, but they cannot exceed a certain quantity, otherwise N, the top of the crank, would strike the rim of the wheel. The vibrations may be easily increased to 180°, by placing the pins at the very edge of the wheel; and by placing them at the points of long teeth, so that the crank may get in between them, the vibrations may be carried to a much greater extent.

The construction just described is exceedingly ingenious; and if the machinery be well executed, this scapement will excel the horizontal scapement of Graham, both as it has but two acting faces to form, and as it admits of making the circle of rest extremely small, without lessening the acting face of the pallet. The construction is, however, very delicate and difficult, and must require a very nice workman.

An

WATCH WORK. PLATE DLXXI.

Fig. 1.

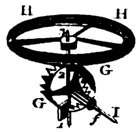


Fig. 2.

Fig. 3.

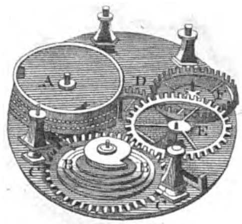


Fig. 4.

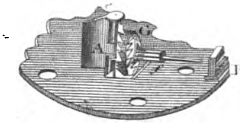


Fig. 5.

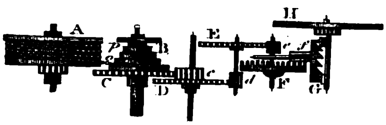


Fig. 6.

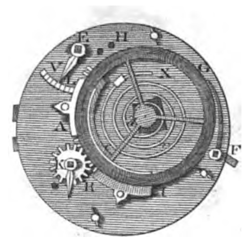


Fig. 7.

Fig. 8.

Fig. 9.

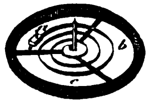


Fig. 10.

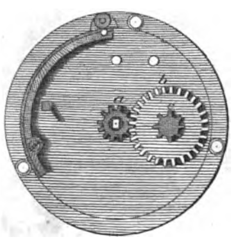


Fig. 11.

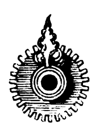
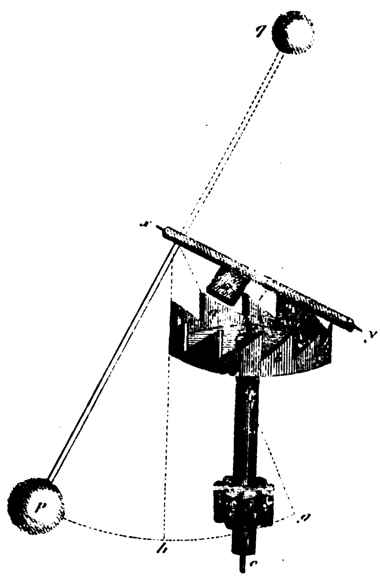


Fig. 12.



W. Train Sculpt.

Fig. 13.

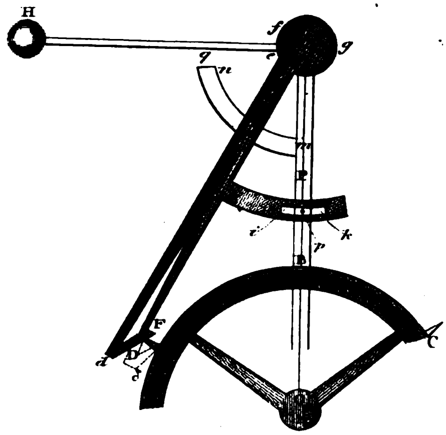


Fig. 14.

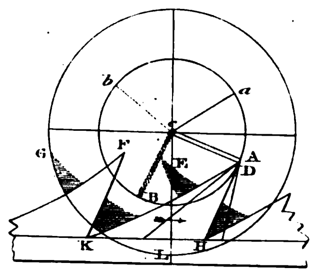


Fig. 16.

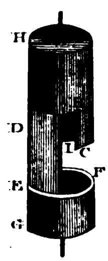


Fig. 17.

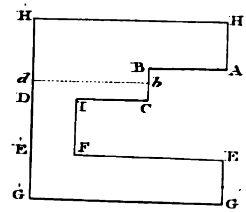


Fig. 15.

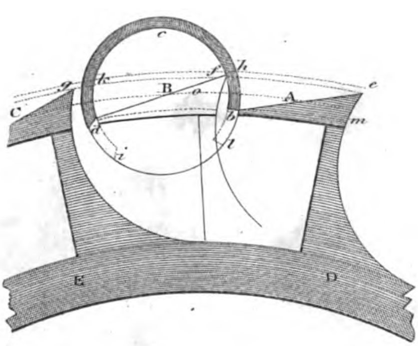


Fig. 18.

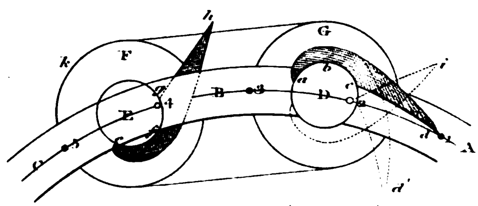


Fig. 19.

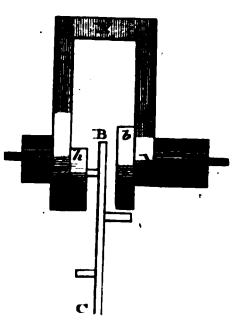
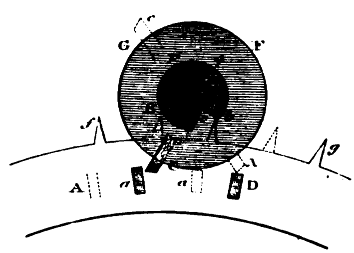


Fig. 20.



W. [illegible] Sculp.t

Watch | Water.

10 Duplaie's scapement. Fig. 20.

An excellent scapement of much more easy construction, is that commonly called *Duplaie's scapement*, and with this we shall conclude our account of watch-work. Fig. 20. represents the essential parts somewhat magnified. AD a portion of the balance-wheel, having teeth *f*, *h*, *g*, at the circumference. These teeth are for producing the *rest* of the wheel, while the balance is making excursions beyond the scapement. This is effected by an agate cylinder *s p g*, on the verge. This cylinder has a notch *o*. When the cylinder turns round in the direction *o p g*, the notch easily passes the tooth B which is resting on the cylinder surface; but when it returns in the direction *b p o*, the tooth B gets into the notch and follows it, pressing on one side of it till the notch comes into the position *o*. The tooth being then in the position *h*, escapes from the notch, and another tooth drops on the convex surface of the cylinder at B. The balance-wheel is also furnished with a set of flat-sided pins, standing upright on its rim represented by *a* D. There is likewise fixed on the verge a larger cylinder GFC above the smaller one *o p q*, with its lower surface clear of the wheel, and having a pallet C, of sapphire, firmly indented into it, and projecting so far as to keep clear of the pins on the wheel. The position of this cylinder, with respect to the smaller one below it, is such that the tooth *b* being escaped from the notch, the pallet C has just past the pin *a*, which was at A while B rested on the small cylinder; but it moved from A to *a*, while B moved to *b*. The wheel being now at liberty, the pin *a* exerts its pressure on the pallet C in the most direct manner, and gives it a strong impulsion, following and accelerating it till another tooth stops on the little cylinder. The angle of scapement depends partly on the projection of the pallet, and partly on the diameter of the small cylinder, and the advance of the tooth B into the notch. Independent of the action on the small cylinder, the angle of scapement would be the whole arch of the large cylinder between C and *x*. But *a* stops before it be clear of the pallet, and the arch of impulsion is shortened by all the space described by the pin while a tooth moves from B to *b*. It stops at *d*.

For an account of other scapements we must refer our readers to the *Memoirs of the Academy of Sciences at Paris* for 1748, Cummin's *Elements of Clock and Watch-work*, a French work entitled *Machines approuvées par l'Academie des Sciences*, and Young's *Lectures on Natural Philosophy*, vol. i. p. 193, and Plate 16, vol. ii. p. 193.

WATCHING, in *Medicine*, is when the patient cannot sleep. In fevers it is a dangerous symptom, and if long continued ends in a delirium.

WATER, a well known fluid, diffused through the atmosphere, and over the surface of the globe, and abounding in a certain proportion in animals, vegetables, and minerals.

The uses of water are so universally known, that it would be superfluous to enumerate them in this article. It is essential to animal and vegetable life; it makes easy the intercourse between the most distant regions of the world; and it is one of the most useful powers in the mechanic arts. It is often found combined with various substances, and is then frequently beneficial in curing or alleviating diseases.

Those properties of water which fit it for answering mechanical purposes are explained in other articles of this work (see HYDRODYNAMICS, PNEUMATICS, N° 3, RESISTANCE, and RIVERS); and for the discovery of the composition of water, see CHEMISTRY *Index*.

Water.

Mineral WATERS. For the method of analysing them, see also CHEMISTRY *Index*.

Under the title of *MINERAL Waters*, we have given an analysis of the most remarkable waters in Europe.

Holy WATER, which is made use of in the church of Rome, as also by the Greeks, and by the other Christians of the East of all denominations, is water with a mixture of salt, blessed by a priest according to a set form of benediction. It is used in the blessing of persons, things, and places; and is likewise considered as a ceremony to excite pious thoughts in the minds of the faithful.

The priests, in blessing it, first, in the name of God, commands the devils not to hurt the persons who shall be sprinkled with it, nor to abuse the things, nor disquiet the places, which shall likewise be so sprinkled: He then prays that health, safety, and the favour of heaven, may be enjoyed by such persons, and by those who shall use such things, or dwell in such places. Vestments, vessels, and other such things that are set apart for divine service, are sprinkled with it. It is sometimes sprinkled on cattle, with an intention to free or preserve them from diabolical enchantments; and in some spiritual books there are prayers to be said on such occasions, by which the safety of such animals, as being a temporal blessing to the possessors, is begged of God, whose providential care is extended to all his creatures. The hope which Catholics entertain of obtaining such good effects from the devout use of holy water, is grounded on the promise made to believers by Christ (St Mark xvi. 17.), and on the general efficacy of the prayers of the church; the petition of which prayers God is often pleased to grant; though sometimes, in his Providence, he sees it not expedient to do so. That such effects have been produced by holy water in a remarkable manner, has been asserted by many authors of no small weight; as, namely, by St Epiphanius, Haer. 30th; St Hierom, in the Life of St Hilarion; Theodoret *Hist. Eccl.* lib. v. cap. 21.; Palladius, *Hist. Laus.*; Bede, lib. v. cap. 4.

As a ceremony (says the Catholic), water brings to our remembrance our baptism; in which, by water, we were cleansed from original sin. It also puts us in mind of that purity of conscience which we ought to endeavour always to have, but especially when we are going to worship our God. The salt, which is put into the water to preserve it from corrupting, is also a figure of divine grace, which preserves our souls from the corruption of sin; and is likewise an emblem of that wisdom and discretion which ought to season every action that a Christian does, and every word that he says. It is wont to be blessed and sprinkled in churches on Sundays, in the beginning of the solemn office. It is kept in vessels at the doors of the same churches, that it may be taken by the faithful as they enter in. It is also often kept in private houses and chambers.

Putrid WATER, is that which has acquired an offensive smell and taste by the putrescence of animal or vegetable substances contained in it. It is in the highest degree pernicious to the human frame, and capable of bringing on mortal diseases even by its smell. It is not always from the apparent muddiness of waters that we

can

Water.

can judge of their disposition to putrefy; some which are seemingly very pure, being more apt to become putrid than others which appear much more mixed with heterogeneous matters. Under the article ANIMALCULE, N° 33, is mentioned a species of insects which have the property of making water stink to an incredible degree, though their bulk in proportion to the fluid which surrounds them is less than that of one to a million. Other substances no doubt there are which have the same property; and hence almost all water which is confined from the air is apt to become offensive, even though kept in glass or stoneware vessels. Indeed it is a common observation, that water keeps much longer sweet in glass vessels, or in those of earthen or stoneware than in those of wood, where it is exceedingly apt to putrefy. Hence, as ships can only be supplied with water kept in wooden casks, sailors are extremely liable to those diseases which arise from putrid water; and the discovery of a method by which water could easily be prevented from becoming putrid at sea would be exceedingly valuable. This may indeed be done by quicklime; for when water is impregnated with it, all putrescent matters are either totally destroyed, or altered in such a manner as never to be capable of undergoing the putrefactive fermentation again. But a continued use of lime-water could not fail of being pernicious, and it is therefore necessary to throw down the lime; after which the water will have all the purity necessary for preserving it free from putrefaction. This can only be done by means of fixed air; and mere exposure in broad shallow vessels to the atmosphere would do it without any thing else, only taking care to break the crust which formed upon it. Two methods, however, have been thought of for doing this with more expedition. The one, invented by Dr Alston, is, by throwing into the water impregnated with lime a quantity of magnesia. The lime attracts fixed air more powerfully than magnesia; in consequence of which the latter parts with it to the lime: and thus becoming insoluble, falls along with the caustic magnesia to the bottom, and thus leaves the water perfectly pure. Another method is that of Mr Henry, who proposes to throw down the lime by means of an effervescing mixture of oil of vitriol and chalk put down to the bottom of the water cask. His apparatus for this purpose is as simple as it can well be made, though is is hardly probable that sailors will give themselves the trouble of using it; and Dr Alston's scheme would seem better calculated for them, were it not for the expence of the magnesia; which indeed is the only objection made to it by Mr Henry. Putrid water may be restored and made potable by a process of the same kind.

Of late it has been discovered that charcoal possesses many unexpected properties, and, among others, that of preserving water from corruption, and of purifying it after it has been corrupted. Mr Lowitz, whose experiments on charcoal have been published in Crell's Chemical Journal, has turned his attention to this subject in a memoir read to the Economical Society at Petersburgh. He found that the effect of charcoal was rendered much more speedy by using along with it some sulphuric acid. One ounce and a half of charcoal in powder, and 24 drops of concentrated sulphuric acid (oil of vitriol), are sufficient to purify three pints and a half of corrupted water, and do not communicate to it any sensible acidity. This small quantity of acid renders it unnecessary to use more than a third part of the charcoal powder which would otherwise be wanted; and the less of that powder is employed, the less is the quantity of water lost by the operation, which, in sea-voyages, is an object worthy of consideration. In proportion to the quantity of acid made use of, the quantity of charcoal may be diminished or augmented. All acids produce nearly the same effects: neutral salts also, particularly nitre and sea-salt, may be used, but sulphuric acid is preferable to any of these; water which is purified by means of this acid and charcoal will keep a longer time than that which is purified by charcoal alone. When we mean to purify any given quantity of corrupted water, we should begin by adding to it as much powder of charcoal as is necessary to deprive it entirely of its bad smell. To ascertain whether that quantity of powdered charcoal was sufficient to effect the clarification of the said water, a small quantity of it may be passed through a linen bag, two or three inches long; if the water, thus filtrated, still has a turbid appearance, a fresh quantity of powdered charcoal must be added, till it is become perfectly clear: the whole of the water may then be passed through a filtering bag, the size of which should be proportioned to the quantity of water. If sulphuric acid, or any other, can be procured, a small quantity of it should be added to the water, before the charcoal powder.

The cleaning of the casks in which water is to be kept in sea-voyages should never be neglected: they should be well washed with hot water and sand, or with any other substance capable of removing the mucilaginous particles, and afterwards a quantity of charcoal dust should be employed, which will entirely deprive them of the musty or putrid smell they may have contracted.—The charcoal used for purifying water should be well burnt, and afterwards beat into a fine powder.

Sea-WATER. See *SEA-Water*.

WATER-Carts, carriages constructed for the purpose of watering the roads for several miles round London; a precaution absolutely necessary near the metropolis, where, from such a vast daily influx of carriages and horses, the dust would otherwise become quite insufferable in hot dry weather. Pumps are placed at proper distances to supply these carts.

WATER-Ordeal. See ORDEAL.

WATER, among jewellers, is properly the colour or lustre of diamonds and pearls. The term, though less properly, is sometimes used for the hue or colour of other stones.

WATER-Bellows. See *Machines for blowing Air into FURNACES*.

WATER-Colours, in *Painting*, are such colours as are only diluted and mixed up with gum-water, in contradistinction to oil-colours. See *COLOUR-Making*.

WATER-Gang, a channel cut to drain a place by carrying off a stream of water.

WATER-Hen. See PARRA, ORNITHOLOGY *Index*.

WATER-Lines of a Ship, certain horizontal lines supposed to be drawn about the outside of a ship's bottom, close to the surface of the water in which she floats. They are accordingly higher or lower upon the bottom, in proportion to the depth of the column of water required to float her.

WATER-Logged, the state of a ship when, by receiving a great quantity of water into the hold, by leaking, &c. she

Water logged ‖ Water Spout.

she has become heavy and inactive upon the sea, so as to yield without resistance to the efforts of every wave rushing over her decks. As, in this dangerous situation, the centre of gravity is no longer fixed, but fluctuating from place to place, the stability of the ship is utterly lost: she is therefore almost totally deprived of the use of her sails, which would operate to overset her, or press the head under water. Hence there is no resource for the crew, except to free her by the pumps, or to abandon her by the boats as soon as possible.

WATER-Sail, a small sail spread occasionally under the lower studding-sail, or driver boom, in a fair wind and smooth sea.

WATER-Ouzel. See TURDUS, ORNITHOLOGY *Index*.

WATER-Spout, an extraordinary meteor, consisting of a large mass of water collected into a sort of column, and moved with rapidity along the surface of the sea.

The best account of the water-spout which we have met with is in the Phil. Trans. Abridged, vol. iii. as observed by Mr Joseph Harris, May 21. 1732, about sunset, lat. 32° 30′ N.; long. 9° E. from Cape Florida.

"When first we saw the spout (says he), it was whole and entire, and much of the shape and proportion of a speaking trumpet; the small end being downwards, and reaching to the sea, and the big end terminated in a black thick cloud. The spout itself was very black, and the more so the higher up. It seemed to be exactly perpendicular to the horizon, and its sides perfectly smooth, without the least ruggedness. Where it fell the spray of the sea rose to a considerable height, which made somewhat the appearance of a great smoke. From the first time we saw it, it continued whole about a minute, and till it was quite dissipated about three minutes. It began to waste from below, and so gradually up, while the upper part remained entire, without any visible alteration, till at last it ended in the black cloud above; upon which there seemed to fall a very heavy rain in that neighbourhood.—There was but little wind, and the sky elsewhere was pretty serene."

Water-spouts have by some been supposed to be merely electrical in their origin; particularly by Signior Beccaria, who supported his opinion by some experiments. But if we attend to the successive phenomena necessary to constitute a complete water-spout through their various stages, we shall be convinced, that recourse must be had to some other principle in order to obtain a complete solution.

Dr Franklin, in his Physical and Meteorological Observations, supposes a water-spout and a whirlwind to proceed from the same cause; their only difference being, that the latter passes over the land, and the former over the water. This opinion is corroborated by M. de la Pryme, in the Philosophical Transactions, where he describes two spouts observed at different times in Yorkshire, whose appearances in the air were exactly like those of the spouts at sea, and their effects the same as those of real whirlwinds.

A fluid moving from all points horizontally towards a centre, must at that centre either mount or descend. If a hole be opened in the middle of the bottom of a tub filled with water, the water will flow from all sides to the centre, and there descend in a whirl: but air flowing on or near the surface of land or water, from all sides towards a centre, must at that centre ascend; because the land or water will hinder its descent.

Water Spout.

The doctor, in proceeding to explain his conceptions, begs to be allowed two or three positions, as a foundation for his hypothesis. 1. That the lower region of air is often more heated, and so more rarefied, than the upper, and by consequence specifically lighter. The coldness of the upper region is manifested by the hail, which falls from it in warm weather. 2. That heated air may be very moist, and yet the moisture so equally diffused and rarefied as not to be visible till colder air mixes with it; at which time it condenses and becomes visible. Thus our breath, although invisible in summer, becomes visible in winter.

These circumstances being granted, he presupposes a tract of land or sea, of about 60 miles in extent, unsheltered by clouds and unrefreshed by the wind, during a summer's day, or perhaps for several days without intermission, till it becomes violently heated, together with the lower region of the air in contact with it; so that the latter becomes specifically lighter than the superincumbent higher region of the atmosphere, wherein the clouds are usually floated: he supposes also that the air surrounding this tract has not been so much heated during those days, and therefore remains heavier. The consequence of this, he conceives, should be, that the heated lighted air should ascend, and the heavier descend; and as this rising cannot operate throughout the whole tract at once, because that would leave too extensive a vacuum, the rising will begin precisely in that column which happens to be lightest or most rarefied; and the warm air will flow horizontally from all parts of this column, where the several currents meeting, and joining to rise, a whirl is naturally formed, in the same manner as a whirl is formed in a tub of water, by the descending fluid receding from all sides of the tub towards the hole in the centre.

And as the several currents arrive at this central rising column with a considerable degree of horizontal motion, they cannot suddenly change it to a vertical motion: therefore as they gradually, in approaching the whirl, decline from right to curve or circular lines, so, having joined the whirl, they ascend by a spiral motion; in the same manner as the water descends spirally through the hole in the tub before mentioned.

Lastly, as the lower air nearest the surface is more rarefied by the heat of the sun, it is more impressed by the current of the surrounding cold and heavy air which is to assume its place, and consequently its motion towards the whirl is swiftest, and so the force of the lower part of the whirl strongest, and the centrifugal force of its particles greatest. Hence the vacuum which incloses the axis of the whirl should be greatest near the earth or sea, and diminish gradually as it approaches the region of the clouds, till it ends in a point.

This circle is of various diameters, sometimes very large.

If the vacuum passes over water, the water may rise in a body or column therein to the height of about 32 feet. The whirl of air may be as invisible as the air itself, though reaching in reality from the water to the region of cool air, in which our low summer thunder-clouds commonly float; but it will soon become visible at its extremities. The agitation of the water under the whirling of the circle, and the swelling and rising of the water in the commencement of the vacuum, render it visible below. It is perceived above by the warm

warm air being brought up to the cooler region, where its moisture begins to be condensed by the cold into thick vapour, and is then first discovered at the highest part, which being now cooled condenses what rises behind it, and this latter acts in the same manner on the succeeding body; where, by the contact of the vapours, the cold operates faster in a right line downwards, than the vapours themselves can climb in a spiral line upwards: they climb however; and as by continual addition they grow denser, and by consequence increase their centrifugal force, and being risen above the concentrating currents that compose the whirl, they fly off, and form a cloud.

It seems easy to conceive, how by this successive condensation from above, the spout appears to drop or descend from the cloud, although the materials of which it is composed are all the while ascending. The condensation of the moisture contained in so great a quantity of warm air as may be supposed to rise in a short time in this prodigiously rapid whirl, is perhaps sufficient to form a great extent of cloud; and the friction of the whirling air on the sides of the column may detach great quantities of its water, disperse them into drops, and carry them up in the spiral whirl mixed with the air. The heavier drops may indeed fly off, and fall into a shower about the spout; but much of it will be broken into vapour, and yet remain visible.

As the whirl weakens, the tube may apparently separate in the middle; the column of water subsiding, the superior condensed part drawing up to the cloud. The tube or whirl of air may nevertheless remain entire, the middle only becoming invisible, as not containing any visible matter.

Dr Lindsay, however, in several letters published in the Gentleman's Magazine, has controverted this theory of Dr Franklin, and endeavoured to prove that water-spouts and whirlwinds are distinct phenomena; and that the water which forms the water-spout, does not ascend from the sea, as Dr Franklin supposes, but descends from the atmosphere. Our limits do not permit us to insert his arguments here, but they may be seen in the Gentleman's Magazine, volume li. p. 559, 615; vol. liii. p. 1025; and vol. lv. p. 594. We cannot avoid observing, however, that he treats Dr Franklin with a degree of asperity to which he is by no means entitled, and that his arguments, even if conclusive, prove nothing more than that some water-spouts certainly descend; which Dr Franklin hardly ever ventured to deny. There are some very valuable dissertations on this subject by Professor Wilcke of Upsal.

WATER-WORKS.

UNDER this name may be comprehended almost every hydraulic structure or contrivance; such as canals, conduits, locks, mills, water engines, &c. But they may be conveniently arranged under two general heads, 1st, Works which have for their object the conducting, raising, or otherwise managing, of water; and, 2dly, Works which derive their efficacy from the impulse or other action of water. The *first* class comprehends the methods of simply conducting water in aqueducts or in pipes for the supply of domestic consumption or the working of machinery: It comprehends also the methods of procuring the supplies necessary for these purposes, by means of pumps, water, or fire engines. It also comprehends the subsequent management of the water thus conducted, whether in order to make the proper distribution of it according to the demand, or to employ it for the purpose of navigation, by lockage, or other contrivances. —And in the prosecution of these things many subordinate problems will occur, in which practice will derive great advantages from a scientific acquaintance with the subject. The *second* class of water-works is of much greater variety, comprehending almost every kind of hydraulic machine; and would of itself fill volumes. Many of these have already occurred in various articles of this Dictionary. In describing or treating them, we have tacitly referred the discussion of their general principles, in which they all resemble each other, to some article where they could be taken in a connected body, susceptible of general scientific discussion, independent of the circumstances which of necessity introduced the particular modifications required by the uses to which the structures were to be applied. That part of the present article, therefore, which embraces these common principles, will chiefly relate to the theory of water mills, or rather of water wheels; because, when the necessary motion is given to the axis of the water wheel, this may be set to the performance of any task whatever.

CLASS I.

1. *Of the Conducting of Water.*

THIS is undoubtedly a business of great importance, and makes a principal part of the practice of the civil engineer: It is also a business so imperfectly understood, that we believe that very few engineers can venture to say, with tolerable precision, what will be the quantity of water which his work will convey, or what plan and dimensions of conduit will convey the quantity which may be proposed. For proof of this we shall only refer our readers to the facts mentioned in the article RIVERS, N° 27, &c.

In that article we have given a sort of history of the progress of our knowledge in hydraulics, a branch of mechanical philosophy which seems to have been entirely unknown to the ancients. Even Archimedes, the author of almost all that we know in hydrostatics, seems to have been entirely ignorant of any principles by which he could determine the motion of water. The mechanical science of the ancients seems to have reached no farther than the doctrine of equilibrium among bodies at rest. Guglielmini first ventured to consider the motion of water in open canals and in rivers. Its motion in pipes had been partially considered in detached

Water-works.

tached scraps by others, but not so as to make a body of doctrine. Sir Isaac Newton first endeavoured to render hydraulics susceptible of mathematical demonstration: But his fundamental proposition has not yet been freed from very serious objections; nor have the attempts of his successors, such as the Bernoullis, Euler, D'Alembert, and others, been much more successful: so that hydraulics may still be considered as very imperfect, and the general conclusions which we are accustomed to receive as fundamental propositions are not much better than matters of observation, little supported by principle, and therefore requiring the most scrupulous caution in the application of them to any hitherto untried case. When experiments are multiplied so as to include as great a variety of cases as possible; and when these are cleared of extraneous circumstances, and properly arranged, we must receive the conclusions drawn from them as the general laws of hydraulics. The experiments of the abbé Bossut, narrated in his *Hydrodynamique*, are of the greatest value, having been made in the cases of most general frequency, and being made with great care. The greatest service, however, has been done by the chevalier Buat, who saw the folly of attempting to deduce an accurate theory from any principles that we have as yet learned, and the necessity of adhering to such a theory as could be deduced from experiment alone, independent of any more general principles. Such a theory must be a just one, if the experiments are really general, unaffected by the particular circumstances of the case, and if the classes of experiment are sufficiently comprehensive to include all the cases which occur in the most important practical questions. Some principle was necessary, however, for connecting these experiments. The sufficiency of this principle was not easily ascertained. Mr Buat's way of establishing this was judicious. If the principle is ill-founded, the results of its combination in cases of actual experiments must be irregular; but if experiments, seemingly very unlike, and in a vast variety of dissimilar cases, give a train of results which is extremely regular and consistent, we may presume that the principle, which in this manner harmonizes and reconciles things so unlike, is founded in the nature of things; and if this principle be such as is agreeable to our clearest notions of the internal mechanism of the motions of fluids, our presumption approaches to conviction.

Proceeding in this way, the chevalier Buat has collected a prodigious number of facts, comprehending almost every case of the motion of fluids. He first classed them according to their resemblance in some one particular, and observed the differences which accompanied their differences in other circumstances; and by considering what could produce these differences, he obtained general rules, deduced from fact, by which these differences could be made to fall into a regular series. He then arranged all the experiments under some other circumstances of resemblance, and pursued the same method; and by following this out, he has produced a general proposition, which applies to the whole of this numerous list of experiments with a precision far exceeding our utmost hopes. This proposition is contained in N° 59. of the article RIVERS, and is there offered as one of the most valuable results of modern science.

We must, however, observe, that of this list of experiments there is a very large class, which is not direct, but requires a good deal of reflection to enable us to draw a confident conclusion; and this is in cases which are very frequent and important, viz. where the declivity is exceedingly small, as in open canals and rivers. The experiments were of the following forms: Two large cisterns were made to communicate with each other by means of a pipe. The surface of the water in these cisterns were made to differ only by a small fraction of an inch: and it is supposed that the motion in the communicating pipe will be the same as in a very long pipe, or an open canal, having this very minute declivity. We have no difficulty in admitting the conclusion; but we have seen it contested, and it is by no means intuitive. We had entertained hopes that this important case would have been determined by direct experiments, which the writer of this article was commissioned to make by the Board for Encouraging Improvements and Manufactures in Scotland: But the infirm state of his health was always an effectual bar to the accomplishment of this desirable object. This, however, need not occasion any hesitation in the adoption of M. Buat's general proposition, because the experiments which we are now criticising fall in precisely with the general train of the rest, and show no *general* deviation which would indicate a fallacy in principle.

We apprehend it to be quite unnecessary to add much to what has been already delivered on the motion of waters in an open canal. Their *general progressive* motion, and consequently the quantity delivered by an aqueduct of any slope and dimension, are sufficiently determined; and all that is wanted is the tables which we promised in N° 65. of the article RIVERS, by which any person who understands common arithmetic may, in five minutes time or less, compute the quantity of water which will be delivered by the aqueduct, canal, conduit, or pipe; for the theorem in N° 59. of this article applies to them all without distinction. We therefore take this opportunity of inserting these tables, which have been computed on purpose for this work with great labour.

TABLE I. *Logarithms of the Values of the Numerator of the Fraction* $\frac{307\,(\sqrt{d}-0,1)}{\sqrt{s}-\mathrm{L}\sqrt{s+1,6}}$ *for every Value of the Hydraulic mean Depth* d: *Also the Value of* $0,3\,(\sqrt{d}-0,1)$.

d.	Log. of 307 ($\sqrt{d}$—0,1)	0,3 × ($\sqrt{d}$—0,1)	d.	Log. of 307 ($\sqrt{d}$—0,1)	0,3 × ($\sqrt{d}$—0,1)	d.	Log. of 307 ($\sqrt{d}$—0,1)	0,3 × ($\sqrt{d}$—0,1)	d.	Log. of 307 ($\sqrt{d}$—0,1)	0,3 × ($\sqrt{d}$—0,1)
0,1	1.82208	0,06	4,9	2.81216	0,63	9,7	2.96634	0,9	54	3.34738	2,17
0,2	2.02786	0,1	5,0	2.81674	0,63	9,8	2.96865	0,91	55	3.35143	2,19
0,3	2.13753	0,13	5,1	2.82125	0,65	9,9	2.97093	0,91	56	3.35539	2,21
0,4	2.21343	0,16	5,2	2.82567	0,65	10	2.97319	0,92	57	3.35928	2,23
0,5	2.27040	0,18	5,3	2.83000	0,66	11	2.99454	0,97	58	3.36312	2,25
0,6	2.31618	0,2	5,4	2.83222	0,67	12	3.01401	1,01	59	3.36687	2,27
0,7	2.35441	0,22	5,5	2.83840	0,67	13	3.03189	1,05	60	3.37057	2,3
0,8	2.38719	0,24	5,6	2.84248	0,68	14	3.04843	1,09	61	3.37421	2,31
0,9	2.41588	0,25	5,7	2.84648	0,68	15	3.06383	1,13	62	3.37778	2,33
1,0	2.44138	0,27	5,8	2.85043	0,69	16	3.07820	1,17	63	3.38130	2,35
1,1	2.46431	0,28	5,9	2.85431	0,69	17	3.09170	1,21	64	3.38477	2,37
1,2	2.46518	0,3	6,0	2.85812	0,7	18	3.10441	1,24	65	3.38817	2,39
1,3	2.50426	0,31	6,1	2.86185	0,7	19	3.11644	1,28	66	3.39158	2,41
1,4	2.52185	0,32	6,2	2.86554	0,71	20	3.12783	1,31	67	3.39483	2,42
1,5	2.53818	0,34	6,3	2.86916	0,72	21	3.13867	1,34	68	3.39809	2,44
1,6	2.55345	0,35	6,4	2.87271	0,73	22	3.14899	1,38	69	3.40130	2,46
1,7	2.56769	0,36	6,5	2.87622	0,73	23	3.15885	1,41	70	3.40446	2,48
1,8	2.58112	0,37	6,6	2.87966	0,74	24	3.16828	1,44	71	3.40758	2,49
1,9	2.59381	0,38	6,7	2.88306	0,75	25	3.17734	1,47	72	3.41065	2,51
2,0	2.60580	0,39	6,8	2.88641	0,75	26	3.18601	1,5	73	3.41369	2,53
2,1	2.61713	0,4	6,9	2.88971	0,76	27	3.19438	1,53	74	3.41667	2,55
2,2	2.62803	0,41	7,0	2.89296	0,76	28	3.20243	1,56	75	3.41962	2,57
2,3	2.63839	0,42	7,1	2.89614	0,77	29	3.21020	1,58	76	3.42253	2,58
2,4	2.64827	0,44	7,2	2.89930	0,77	30	3.21770	1,61	77	3.42540	2,60
2,5	2.65772	0,45	7,3	2.90241	0,78	31	3.22495	1,64	78	3.42823	2,62
2,6	2.66681	0,45	7,4	2.90549	0,78	32	3.23196	1,67	79	3.43103	2,63
2,7	2.67556	0,46	7,5	2.90851	0,79	33	3.23877	1,69	80	3.43380	2,65
2,8	2.68395	0,47	7,6	2.91150	0,79	34	3.24537	1,72	81	3.43653	2,67
2,9	2.69207	0,48	7,7	2.91445	0,8	35	3.25176	1,74	82	3.43923	2,69
3,0	2.69989	0,49	7,8	2.91734	0,8	36	3.25799	1,77	83	3.44189	2,7
3,1	2.70743	0,5	7,9	2.92022	0,81	37	3.26404	1,79	84	3.44452	2,72
3,2	2.71472	0,51	8,0	2.92305	0,82	38	3.26993	1,82	85	3.44712	2,74
3,3	2.72181	0,52	8,1	2.92584	0,82	39	3.27566	1,84	86	3.44968	2,75
3,4	2.72866	0,53	8,2	2.92860	0,83	40	3.28125	1,87	87	3.45222	2,77
3,5	2.73531	0,53	8,3	2.93133	0,83	41	3.28669	1,89	88	3.45473	2,78
3,6	2.74178	0,54	8,4	2.93403	0,84	42	3.29201	1,91	89	3.45721	2,79
3,7	2.74805	0,55	8,5	2.93670	0,84	43	3.29720	1,93	90	3.45965	2,81
3,8	2.75417	0,56	8,6	2.93933	0,85	44	3.30227	1,95	91	3.46208	2,83
3,9	2.76009	0,56	8,7	2.94192	0,85	45	3.30722	1,98	92	3.46448	2,85
4,0	2.76589	0,57	8,8	2.94449	0,86	46	3.31207	2,00	93	3.46685	2,86
4,1	2.77153	0,58	8,9	2.94703	0,86	47	3.31681	2,03	94	3.46920	2,88
4,2	2.77704	0,59	9,0	2.94954	0,87	48	3.32145	2,05	95	3.47152	2,89
4,3	2.78240	0,59	9,1	2.95202	0,87	49	3.32599	2,07	96	3.47381	2,91
4,4	2.78765	0,6	9,2	2.95447	0,88	50	3.33043	2,09	97	3.47608	2,93
4,5	2.79277	0,6	9,3	2.95690	0,88	51	3.33480	2,11	98	3.47833	2,94
4,6	2.79779	0,61	9,4	2.95930	0,89	52	3.33908	2,13	99	3.48056	2,95
4,7	2.80269	0,62	9,5	2.96167	0,89	53	3.34327	2,15	100	3.48277	2,97
4,8	2.80747	0,63	9,6	2.96402	0,9						

TABLE

Table II. *Logarithms of the Values of the Denominator of the Fraction* $\frac{307(\sqrt{d}-0,1)}{\sqrt{s}-L\sqrt{s+1,6}}$ *for every Value of the Slopes.*

s.	Log. of $\sqrt{s}-L\sqrt{s+1,6}$	s.	Log. of $\sqrt{s}-L\sqrt{s+1,6}$	s.	Log. of $\sqrt{s}-L\sqrt{s+1,6}$	s.	Log. of $\sqrt{s}-L\sqrt{s+1,6}$	s.	Log. of $\sqrt{s}-L\sqrt{s+1,6}$	s.	Log. of $\sqrt{s}-L\sqrt{s+1,6}$
1,0	9.71784	7,3	0.20651	45	0.67997	170	1.01983	800	1.39690	5200	1.83142
1,1	9.74210	7,4	0.20997	46	0.68574	180	1.03410	810	1.39985	5300	1.83575
1,2	9.76388	7,5	0.21336	47	0.69135	190	1.04751	820	1.40277	5400	1.84002
1,3	9.78376	7,6	0.21674	48	0.69688	200	1.06026	830	1.40564	5500	1.84421
1,4	9.80202	7,7	0.22109	49	0.70226	210	1.07237	840	1.40678	5600	1.84833
1,5	9.81882	7,8	0.22335	50	0.70749	220	1.08390	850	1.41128	5700	1.85237
1,6	9.83461	7,9	0.22663	51	0.71265	230	1.09489	860	1.41408	5800	1.85634
1,7	9.84930	8,0	0.22982	52	0.71767	240	1.10542	870	1.41683	5900	1.86022
1,8	9.86314	8,1	0.23297	53	0.72263	250	1.11553	880	1.41953	6000	1.86404
1,9	9.87622	8,2	0.23611	54	0.72746	260	1.12523	890	1.42220	6100	1.86778
2,0	9.88857	8,3	0.23923	55	0.73223	270	1.13453	900	1.42487	6200	1.87146
2,1	9.90031	8,4	0.24229	56	0.73695	280	1.14345	910	1.42746	6300	1.87507
2,2	9.91153	8,5	0.24532	57	0.74155	290	1.15204	920	1.43005	6400	1.87863
2,3	9.92267	8,6	0.24832	58	0.74601	300	1.16035	930	1.43263	6500	1.88213
2,4	9.93247	8,7	0.25128	59	0.75043	310	1.16838	940	1.43515	6600	1.88558
2,5	9.94231	8,8	0.25422	60	0.75481	320	1.17612	950	1.43464	6700	1.88898
2,6	9.95173	8,9	0.25709	61	0.75906	330	1.18363	960	1.44011	6800	1.89233
2,7	9.96085	9,0	0.25996	62	0.76328	340	1.19092	970	1.44254	6900	1.89564
2,8	9.96942	9,1	0.26281	63	0.76745	350	1.19803	980	1.44498	7000	1.89891
2,9	9.97818	9,2	0.26560	64	0.77151	360	1.20490	990	1.44737	7100	1.90214
3,0	9.98632	9,3	0.26839	65	0.78276	370	1.21158	1000	1.44976	7200	1.90532
3,1	9.99427	9,4	0.27116	66	0.77945	380	1.21806			7300	1.90845
3,2	0.00200	9,5	0.27387	67	0.78333	390	1.22435	1100	1.47223	7400	1.91154
3,3	0.00945	9,6	0.27656	68	0.78718	400	1.23048	1200	1.49269	7500	1.91458
3,4	0.01669	9,7	0.27921	69	0.79092	410	1.23647	1300	1.51148	7600	1.91757
3,5	0.02373	9,8	0.25186	70	0.76463	420	1.24232	1400	1.52885	7700	1.92052
3,6	0.03064	9,9	0.28450	71	0.79824	430	1.24805	1500	1.54497	7800	1.92344
3,7	0.03733	10,	0.28709	72	0.80182	440	1.25360	1600	1.56014	7900	1.92632
3,8	0.04383			73	0.80536	450	1.25903	1700	1.57416	8000	1.92916
3,9	0.05015	11	0.31170	74	0.80882	460	1.26433	1800	1.58747	8100	1.93197
4,0	0.05638	12	0.33425	75	0.81231	470	1.26951	1900	1.60004	8200	1.93475
4,1	0.06245	13	0.35488	76	0.81571	480	1.27461	2000	1.61195	8300	1.93749
4,2	0.06839	14	0.37420	77	0.81908	490	1.27957	2100	1.62325	8400	1.94020
4,3	0.07412	15	0.39235	78	0.82236	500	1.28445	2200	1.63403	8500	1.94287
4,4	0.07898	16	0.40926	79	0.82562	510	1.28923	2300	1.64432	8600	1.94551
4,5	0.08533	17	0.42521	80	0.82885	520	1.29391	2400	1.65414	8700	1.94811
4,6	0.09081	18	0.44028	81	0.83206	530	1.29851	2500	1.66358	8800	1.95069
4,7	0.09615	19	0.45439	82	0.83525	540	1.30300	2600	1.67261	8900	1.95324
4,8	0.10131	20	0.46776	83	0.83835	550	1.30740	2700	1.68133	9000	1.95576
4,9	0.10644	21	0.48044	84	0.84142	560	1.31172	2800	1.68971	9100	1.95826
5,0	0.11147	22	0.49262	85	0.84442	570	1.31597	2900	1.69780	9200	1.96073
5,1	0.11635	23	0.50433	86	0.84739	580	1.32015	3000	1.70558	9300	1.96317
5,2	0.12108	24	0.51548	87	0.85034	590	1.32426	3100	1.71313	9400	1.96559
5,3	0.12595	25	0.52621	88	0.85327	600	1.32830	3200	1.72042	9500	1.96797
5,4	0.13061	26	0.53656	89	0.85618	610	1.33226	3300	1.72750	9600	1.97033
5,5	0.13519	27	0.54654	90	0.85908	620	1.33614	3400	1.73435	9700	1.97267
5,6	0.13970	28	0.55606	91	0.86189	630	1.33997	3500	1.74099	9800	1.97497
5,7	0.14410	29	0.56526	92	0.86463	640	1.34373	3600	1.74746	9900	1.97726
5,8	0.14844	30	0.57415	93	0.86741	650	1.34743	3700	1.75373	10000	1.97952
5,9	0.15274	31	0.58263	94	0.87017	660	1.35108	3800	1.75984	11000	2.00099
6,0	0.15697	32	0.59095	95	0.87286	670	1.35468	3900	1.76578	12000	2.02056
6,1	0.16113	33	0.59901	96	0.87552	680	1.35823	4000	1.77159	13000	2.03855
6,2	0.16522	34	0.60692	97	0.87818	690	1.36170	4100	1.77725	14000	2.05518
6,3	0.16927	35	0.61448	98	0.88076	700	1.36513	4200	1.78277	15000	2.07065
6,4	0.17322	36	0.62180	99	0.88338	710	1.36851	4300	1.78814	16000	2.08512
6,5	0.17713	37	0.62900	100	0.88593	720	1.37185	4400	1.79339	17000	2.09869
6,6	0.18099	38	0.63599			730	1.37513	4500	1.77851	18000	2.11148
6,7	0.18477	39	0.64276	110	0.91014	740	1.37839	4600	1.80352	19000	2.12357
6,8	0.18854	40	0.64933	120	0.93212	750	1.38157	4700	1.80875	20000	2.13503
6,9	0.19229	41	0.65571	130	0.95236	760	1.38371	4800	1.81321	21000	2.14594
7,0	0.19584	42	0.66200	140	0.97109	770	1.38782	4900	1.81790	22000	2.15633
7,1	0.19886	43	0.66811	150	0.98843	780	1.39089	5000	1.82249	23000	2.16624
7,2	0.20298	44	0.67413	160	1.00466	790	1.39391	5100	1.82699	24000	2.17573

TABLE

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TABLE I. consists of three columns.—*Column* 1. entitled d, contains the hydraulic mean depths of any conduit in inches. This is set down for every 10th of an inch in the first 10 inches, that the answers may be more accurately obtained for pipes, the mean depth of which seldom exceeds three or four inches. The column is continued to 100 inches, which is fully equal to the hydraulic mean depth of any canal.

Column 2. contains the logarithms of the values of $\sqrt{d}-0.1$, multiplied by 307; that is, the logarithm of the numerator of the fraction $\frac{307(\sqrt{d}-0.1)}{\sqrt{s}-\text{L}\sqrt{s+1.6}}$ in N° 65. of the article RIVERS.

Column 3. contains the product of the values of $\sqrt{d}-0.1$ multiplied by 0.3.

TABLE II. consists of two columns.—*Column* 1. entitled s, contains the denominator of the fraction expressing the slope or declivity of any pipe or canal; that is, the quotient of its length divided by the elevation of one extremity above the other. Thus, if a canal of one mile in length be three feet higher at one end than the other, then s is $\frac{5280}{3}$, $=1760$.

Column 2. contains the logarithms of the denominators of the above-mentioned fraction, or of the different values of the quantity $\sqrt{s}-\text{L}\sqrt{s+1.6}$.

These quantities were computed true to the third decimal place. Notwithstanding this, the last figure in about a dozen of the first logarithms of each table is not absolutely certain to the nearest unit. But this cannot produce an error of 1 in 100,000.

Examples of the Use of these Tables.

Example 1. Water is brought into the city of Edinburgh in several mains. One of these is a pipe of five inches diameter. The length of the pipe is 14.637 feet; and the reservoir at Comiston is 44 feet higher than the reservoir into which it delivers the water on the Castle Hill. *Query*, The number of Scotch pints which this pipe should deliver in a minute?

1. We have $d=\frac{5}{4}$, $=1.25$ inches. The logarithm corresponding to this d, being nearly the mean between the logarithms corresponding to 1.2 and 1.3 is 2.49472.

2. We have $s=\frac{14637}{44}$, or 332.7. The logarithm corresponding to this in Table II. is had by taking proportional parts for the difference between the logarithms for $s=330$ and $s=340$, and is 1.18533.

3. From 2.49472
Take 1.18533

Remains 1.30939, the logarithm of 20.385 inches.

4. In column 3. of Table I. opposite to $d=1.2$ and $d=1.3$ are 0.3 and 0.31, of which the mean is 0.305 inches, the correction for viscidity.

5. Therefore the velocity in inches per second is $20.385-0.305$, or 20.08.

6. To obtain the Scotch pints per minute (each containing 103.4 cubic inches), multiply the velocity by 60, and this product by 5^2, and this by 0.7854 (the area of a circle whose diameter is 1), and divide by 103.4. Or, by logarithms,

Add the log. of 20.08	- -	1.30276
log. of 60″	- -	1.77815
log. of 5^2 or 25	- -	1.39794
log. of 0.7854	- -	9.89509
		4.37394
Subtract the log. of 103.4	- -	2.01451
Remains the log. of 228.8 pints	-	2.35943

Example 2. The canal mentioned in the article RIVERS, N° 63. was 18 feet broad at the surface, and 7 feet at the bottom. It was 4 feet deep, and had a declivity of 4 inches in a mile. *Query*, The mean velocity?

1. The slant side of the canal, corresponding to 4 feet deep and $5\frac{1}{2}$ projection, is 6.8 feet; therefore the border touched by the water is $6.8+7+6.8$, $=20.6$. The area is $4\times\frac{18+7}{2}$, $=50$ square feet. Therefore $d=\frac{50}{20.6}$, $=2.427$ feet, or 29.124 inches. The logarithm corresponding to this in Table I. is 3.21113, and the correction for viscidity from the third column of the same Table is 1.58.

2. The slope is one-third of a foot in a mile, or one foot in three miles. Therefore s is 15.840. The logarithm corresponding to this is 2.08280.

3. From 3.21113
Subtract 2.08280

Remains $1.12833=$log. of 13.438 inches.
Subtract for viscidity 1.58

Velocity per second - 11.858

This velocity is considerably smaller than what was observed by Mr Watt. And indeed we observe, that in the very small declivities of rivers and canals, the formula is a little different. We have made several comparisons with a formula which is essentially the same with Buat's, and comes nearer in these cases. Instead of taking the hyperbolic logarithm of $\sqrt{s+1.6}$, multiply its common logarithm by $2\frac{1}{4}$, or multiply it by 9, and divide the product by 4; and this process is vastly easier than taking the hyperbolic logarithm.

We have not, however, presumed to calculate tables on the authority of our own observations, thinking too respectfully of this gentleman's labours and observations. But this subject will, ere long, be fully established on a series of observations on canals of various dimensions and declivities, made by several eminent engineers during the execution of them. Fortunately Mr Buat's formula is chiefly founded on observations on small canals; and is therefore most accurate in such works where it is most necessary, viz. in mill courses, and other derivations for working machinery.

We now proceed to take notice of a few circumstances which deserve attention, in the construction of canals, in addition to those delivered in the article RIVERS.

When a canal or aqueduct is brought off from a bason or or larger stream, it ought always to be widened at the entry, if it is intended for drawing off a continued stream of water: For such a canal has a slope, without which it can have no current. Suppose it filled to a dead level to the farther end: Take away the bar, and the water immediately begins to flow off at that end. But it is some time before any motion is perceived at the head of the canal, during all which time the motion of the water is augmenting in every part of the canal; consequently the slope is increasing in every part, this being the sole cause of its stream. When the water at the entry *begins* to move, the slope is scarcely sensible there; but it sensibly steepens every moment with the increase of velocity, which at last attains its maximum relative to the slope and dimensions of the whole canal; and this regulates the depth of water in every point down the stream. When all has attained a state of permanency, the slope at the entry *remains* much greater than in any other part of the canal; for this slope must be such as will produce a velocity sufficient for supplying its TRAIN.

And it must be remembered, that the velocity which must be produced greatly exceeds the mean velocity corresponding to the train of the canal. Suppose that this is 25 inches. There must be a velocity of 30 inches at the surface, as appears by the Table in the article RIVERS, N° 80. This must be produced by a real fall at the entry.

In every other part the slope is sufficient, if it merely serves to give the water (already in motion) force enough for overcoming the friction and other resistances. But at the entry the water is stagnant, if in a bason, or it is moving past laterally, if the aqueduct is derived from a river; and, having no velocity whatever in the direction of the canal, it must derive it from its slope. The water therefore which has acquired a permanent form in such an aqueduct, must necessarily take that form which exactly performs the offices requisite in its different portions. The surface remains horizontal in the bason, as to KC (fig. 1.), till it comes near the entry of the canal AB, and there it acquires the form of an undulated curve CDE; and then the surface acquires an uniform slope EF, in the lower part of the canal, where the water is in train.

Plate DLXXIII. fig. 1.

If this is a drain, the discharge is much less than might be produced by the same bed if this sudden slope could be avoided. If it is to be navigated, having only a very gentle slope in its whole length, this sudden slope is a very great imperfection, both by diminishing the depth of water, which might otherwise be obtained along the canal, and by rendering the passage of boats into the bason very difficult, and the coming out very hazardous.

All this may be avoided, and the velocity at the entry may be kept equal to that which forms the train of the canal, by the simple process of enlarging the entry. Suppose that the water could accelerate along the slopes of the canal, as a heavy body would do on a finely polished plane. If we now make the width of the entry in its different parts inversely proportional to the fictitious velocities in those parts, it is plain that the slope of the surface will be made parallel to that of the canal which is in train. This will require a form somewhat like a bell or speaking trumpet, as may easily be shown by a mathematical discussion. It would, however, be so much evasated at the bason as to occupy much room, and it would be very expensive to make such an excavation. But we may, at a very moderate expence of money and room, make the increase of velocity at the entry almost insensible. This should always be done, and it is not all expence: for if it be not done, the water will undermine the banks on each side, because it is moving very swiftly, and will make an excavation for itself, leaving all the mud in the canal below. We may observe this enlargement at the entry of all natural derivations from a bason or lake. It is a very instructive experiment, to fill up this enlargement, continuing the parallel sides of the drain quite to the side of the lake. We shall immediately observe the water grow shallower in the drain, and its performance will diminish. Supposing the ditch carried on with parallel sides quite to the side of the bason, if we build two walls or dykes from the extremities of those sides, bending outwards with a proper curvature (and this will often be less costly than widening the drain), the discharge will be greatly increased. We have seen instances where it was nearly doubled.

The enlargement at the mouths of rivers is generally owing to the same cause. The tide of flood up the river produces a superficial slope opposite to that of the river, and this widens the mouth. This is most remarkable when the tides are high, and the river has little slope.

After this great fall at the entry of the canal, in which all the filaments are much accelerated, and the inferior ones most of all, things take a contrary turn. The water, by rubbing on the bottom and the sides, is retarded; and therefore the section must, from being shallow, become a little deeper, and the surface will be convex for some distance till all comes into train. When this is established, the filaments nearest the bottom and side are moving slowest, and the surface (in the middle especially) retains the greatest velocity, gliding over the rest. The velocity in the canal, and the depth of the section, adjust themselves in such a manner that the difference between the surface of the bason and the surface of the uniform section of the canal corresponds exactly to the velocity. Thus, if this be observed to be two feet in a second, the difference of height will be $\frac{1}{16}$th of an inch.

All the practical questions that are of considerable importance respecting the motion of water in aqueducts, may be easily, though not elegantly, solved by means of the tables.

But it is to be remembered, that these tables relate only to uniform motion, that is, to water that is in train, and where the velocity suffers no change by lengthening the conduit, provided the slope remain the same. It is much more difficult to determine what will be the velocity, &c. in a canal of which nothing is given but the form, and slope, and depth of the entry, without saying how deep the water runs in it. And it is here that the common doctrines of hydraulics are most in fault, and unable to teach us how deep the water will run in a canal, though the depth of the bason at the entry be perfectly known. Between the part of the canal which is in train and the bason, there is an interval where the water is in a state of acceleration, and is afterwards retarded.

The determination of the motions in this interval is exceedingly

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exceedingly difficult, even in a rectangular canal. It was one great aim of M. Buat's experiments to ascertain this by measuring accurately the depth of the water. But he found that when the slope was but a very few inches in the whole length of his canal, it was not in train for want of greater length; and when the slope was still less, the small fractions of an inch, by which he was to judge of the variations of depth, could not be measured with sufficient accuracy. It would be a most desirable point to determine the length of a canal, whose slope and other dimensions are given, which will bring it into train; and what is the ratio which will then obtain between the depth at the entry and the depth which will be maintained. Till this be done, the engineer cannot ascertain by a direct process what quantity of water will be drawn off from a reservoir by a given canal. But as yet this is out of our reach. Experiments, however, are in view which will promote the investigation.

But this and similar questions are of such importance, that we cannot be said to have improved hydraulics, unless we can give a tolerably precise answer. This we can do by a sort of retrograde process, proceeding on the principles of uniform motion established by the Chevalier Buat. We may suppose a train maintained in the canal, and then examine whether this train *can* be produced by any fall that is possible at the entry. If it can, we may be certain that it is so produced, and our problem is solved.

We shall now point out the methods of answering some chief questions of this kind.

Quest. 1. Given the slope s and the breadth w of a canal, and the height H of the surface of the water in the bason above the bottom of the entry; to find the depth h and velocity V of the stream, and the quantity of water Q which is discharged?

The chief difficulty is to find the depth of the stream where it is in train. For this end, we may simplify the hydraulic theorem of uniform motion in N° 59. of the article RIVER; making $V=\frac{\sqrt{Ngd}}{\sqrt{S}}$, where g is the velocity (in inches) acquired in a second by falling, d is the hydraulic mean depth, and $\sqrt{S}$ stands for $\sqrt{S}-L\sqrt{S+1.6}$. N is a number to be fixed by experiment (see RIVER, N° 53.) depending on the contraction or obstruction sustained at the entry of the canal, and it may in most common cases be taken $=244$; so that $\sqrt{Ng}$ may be somewhat less that 307. To find it, we may begin by taking for our depth of stream a quantity h, somewhat smaller than H the height of the surface of the bason above the bottom of the canal. With this depth, and the known width w of the canal, we can find the hydraulic depth d (See RIVERS, N° 48). Then with $\sqrt{d}$ and the slope find V by the Table: make this $V=\frac{\sqrt{Ngd}}{\sqrt{S}}$. This gives $\sqrt{Ng}=\frac{V\sqrt{S}}{\sqrt{d}}$. This value of N$g$ is sufficiently exact; for a small error of depth hardly affects the hydraulic mean depth.

After this preparation, the expression of the mean velocity in the canal will be $\frac{\sqrt{Ng}\sqrt{\frac{wh}{w+2h}}}{\sqrt{S}}$. The height which will produce this velocity is $\frac{Ng}{2GS}\left(\frac{wh}{w+2h}\right)$. Now this is the slope at the entry of the canal which produces the velocity that is afterwards maintained against the obstructions by the slope of the canal. It is therefore $=H-h$. Hence we deduce

$$h=\frac{-\left(w\left(\frac{Ng}{2GS}+1\right)-2H\right)}{4}+\frac{\sqrt{8Hw+\left(w\left(\frac{Ng}{2GS}+1\right)-2H\right)^2}}{4}.$$

If there be no contraction at the entry, $g=G$ and $\frac{9}{2G}=\frac{1}{2}$.

Having thus obtained the depth h of the stream, we obtain the quantity of water by combining this with the width w and the velocity V.

But as this was but an approximation, it is necessary to examine whether the velocity V be possible. This is very easy. It must be produced by the fall $H-h$. We shall have no occasion for any correction of our first assumption, if h has not been extravagantly erroneous, because a small mistake in h produces almost the same variation in d. The test of accuracy, however, is, that h, together with the height which will produce the velocity V, must make up the whole height H. Assuming h too small, leaves $H-h$ too great, and will give a small velocity V, which requires a small value of $H-h$. The error of $H-h$ therefore is always greater than the error we have committed in our first assumption. Therefore when this error of $H-h$ is but a trifle, such as one-fourth of an inch, we may rest satisfied with our answer.

Perhaps the easiest process may be the following: Suppose the whole stream in train to have the depth H. The velocity V obtained for this depth and slope by the Table requires a certain productive height u. Make $\sqrt{H+u}:H=H:h$, and h will be exceedingly near the truth. The reason is obvious.

Quest. 2. Given the discharge (or quantity to be furnished in a second) Q, the height H of the bason above the bottom of the canal, and the slope; to find the dimensions of the canal?

Let x and y be the depth and mean width. It is plain that the equation $\frac{Q}{xy}=\sqrt{2G}\sqrt{H-x}$ will give a value of y in terms of x. Compare this with the value of y obtained from the equation $\frac{Q}{xy}=\frac{\sqrt{Ng}}{\sqrt{S}}\sqrt{\frac{xy}{y+2x}}$. This will give an equation containing only x and known quantities. But it will be very complicated, and we must have recourse to an approximation. This will be best understood in the form of an example.

Suppose the depth at the entry to be 18 inches, and the slope $\frac{1}{1000}$. Let 1200 cubic feet of water per minute be the quantity of water to be drawn off, for working machinery or any other purpose; and let the canal be be supposed of the best form, recommended in N° 69. of the article RIVER, where the base of the sloping side is four-thirds of the height.

The slightest consideration will show us that if $\frac{V^2}{744}$ be taken for the height producing the velocity, it cannot exceed 3 inches, nor be less than 1. Suppose it $=2$, and therefore the depth of the stream in the canal to be 16 inches; find the mean width of the canal by the equation $w=\frac{Q}{h\left(\sqrt{d}-0.1\left(\frac{307}{\sqrt{S}}-0.3\right)\right)}$, in which Q is 20 cubic feet (the 60th part of 1200), $\sqrt{S}$ is $=28.153, =\sqrt{1000}-L\sqrt{1000+1.6}$, and $h=16$. This gives $w=5.52$ feet. The section $n=7.36$ feet, and $V=32.6$ inches. This requires a fall of 1.52 inches instead of 2 inches. Take this from 18, and there remains 16.48, which we shall find not to differ one-tenth of an inch from the exact depth which the water will acquire and maintain. We may therefore be satisfied with assuming 5.36 feet as the mean width, and 3.53 feet for the width at the bottom.

This approximation proceeds on this consideration, that when the width diminishes by a small quantity, and in the same proportion that the depth increases, the hydraulic mean depth remains the same, and therefore the velocity also remains, and the quantity discharged changes in the exact proportion of the section. Any minute error which may result from this supposition, may be corrected by increasing the fall producing the velocity, in the proportion of the first hydraulic mean depth to the mean depth corresponding to the new dimensions found for the canal. It will now become 1.53, and V will be 32.72, and the depth will be 16.47. The quantity discharged being divided by V, will give the section $=7.335$ feet, from which, and the new depth, we obtain 5.344 for the width.

This and the foregoing are the most common questions proposed to an engineer. We asserted with some confidence that few of the profession are able to answer them with tolerable precision. We cannot offend the professional gentlemen by this, when we inform them that the Academy of Sciences at Paris were occupied during several months with an examination of a plan proposed by M. Parcieux, for bringing the waters of the Yvette into Paris; and after the most mature consideration, gave in a report of the quantity of water which M. De Parcieux's aqueduct would yield, and that their report has been found erroneous in the proportion of at least 2 to 5: For the waters have been brought in, and exceed the report in this proportion. Indeed long after the giving in the report, M. Perronet, the most celebrated engineer in France, affirmed that the dimensions proposed were much greater than were necessary, and said that an aqueduct of $5\frac{1}{2}$ feet wide, and $3\frac{1}{2}$ deep with a slope of 15 inches in a thousand fathoms, would have a velocity of 12 or 13 inches per second, which would bring in all the water furnished by the proposed sources. The great diminution of expence occasioned by the alteration encouraged the community to undertake the work. It was accordingly begun, and a part executed. The water was found to run with a velocity of near 19 inches when it was $3\frac{2}{3}$ feet deep. M. Perronet founded his computation on his own experience alone, acknowledging that he had no theory to instruct him. The work was carried no farther, it being found that the city could be supplied at a much smaller expence by steam engines erected by Boulton and Watt. But the facts which occurred in the partial execution of the aqueduct are very valuable. If M. Perronet's aqueduct be examined by our general formula, s will be found $=\frac{1}{4800}$, and $d=18.72$, from which we deduce the velocity $=18\frac{2}{7}$, agreeing with the observation with astonishing precision.

The experiments at Turin by Michaelotti on canals were very numerous, but complicated with many circumstances which would render the discussion too long for this place. When cleared of these circumstances, which we have done with scrupulous care, they are also abundantly conformable to our theory of the uniform motion of running waters. But to return to our subject:

Should it be required to bring off at once from the bason a mill-course, having a determined velocity for driving an undershot wheel, the problem becomes easier, because the velocity and slope combined determine the hydraulic mean depth at once; and the depth of the stream will be had by means of the height which must be taken for the whole depth at the entry, in order to produce the required velocity.

In like manner, having given the quantity to be discharged, and the velocity and the depth at the entry, we can find the other dimensions of the channel; and the mean depth being found, we can determine the slope.

When the slope of a canal is very small, so that the depth of the uniform stream differs but a little from that at the entry, the quantity discharged is but small. But a great velocity, requiring a great fall at the entry, produces a great diminution of depth, and therefore it may not compensate for this diminution, and the quantity discharged may be smaller. Improbable as this may appear, it is not demonstrably false; and hence we may see the propriety of the following

Question 3. Given the depth H at the entry of a rectangular canal, and also its width w; required the slope, depth, and velocity which will produce the greatest possible discharge?

Let x be the unknown depth of the stream. $H-x$ is the productive fall, and the velocity is $\sqrt{2G}\sqrt{H-x}$. This multiplied by wx will give the quantity discharged. Therefore $wx\sqrt{2G}\sqrt{H-x}$ must be made a maximum. The common process for this will give the equation, $2H=3x$, or $x=\frac{2}{3}H$. The mean velocity will be $\sqrt{2G}, \sqrt{\frac{1}{3}H}$; the section will be $\frac{2}{3}wH$, and the discharge $=\frac{2}{3}\sqrt{2G}\,wH\sqrt{\frac{1}{3}H}$, and $d=\frac{\frac{2}{3}wH}{w+\frac{4}{3}H}$. With these data the slope is easily had by the formula for uniform motion.

If the canal is of the trapezoidal form, the investigation is more troublesome, and requires the resolution of a cubic equation.

It may appear strange that increasing the slope of a canal beyond the quantity determined by this problem can diminish the quantity of water conveyed. But one of these two things must happen; either the motion will not acquire uniformity in such a canal for want of length,

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length, or the discharge must diminish. Supposing, however, that it could augment, we can judge how far this can go. Let us take the extreme case by making the canal vertical. In this case it becomes a simple weir or wasteboard. Now the discharge of a wasteboard is $\frac{2}{3}\sqrt{2\,G}\,w\,(h^{\frac{3}{2}}-(\frac{1}{3}h)^{\frac{3}{2}}$. The maximum determined by the preceding problem is to that of the wasteboard of the same dimensions as $H\sqrt{\frac{1}{3}H} : H^{\frac{3}{2}} - (\frac{1}{3}H)^{\frac{3}{2}}$, or as $H\sqrt{\frac{1}{3}H} : H\sqrt{H} - \frac{1}{3}H\sqrt{\frac{1}{3}H}, = 5773 : 6465$, nearly $= 9 : 10$.

Having given the dimensions and slope of a canal, we can discover the relation between its expenditure and the time: or we can tell how much it will sink the surface of a pond in 24 hours, and the gradual progress of this effect; and this might be made the subject of a particular problem. But it is complicated and difficult. In cases where this is an interesting object, we may solve the question with sufficient accuracy, by calculating the expenditure at the beginning, supposing the bason kept full. Then from the known area of the pond, we can tell in what time this expenditure will sink an inch; do the same on the supposition that the water is one-third lower, and that it is two-thirds lower (noticing the contraction of the surface of the pond occasioned by this abstraction of its waters). Thus we shall obtain three rates of diminution, from which we can easily deduce the desired relation between the expenditure and the time.

Aqueducts derived from a bason or river are commonly furnished with a sluice at the entry. This changes exceedingly the state of things. The slope of the canal may be precisely such as will maintain the mean velocity of the water which passes under the sluice; in which case the depth of the stream is equal to that of the sluice, and the velocity is produced at once by the head of water above it. But if the slope is less than this, the velocity of the issuing water is diminished, and the water must rise in the canal. This must check the efflux at the sluice, and the water will be as it were stagnant above what comes through below it. It is extremely difficult to determine at what precise slope the water will begin to check the efflux. The contraction at the lower edge of the board hinders the water from attaining at once the whole depth which it acquires afterwards, when its velocity diminishes by the obstructions. While the regorging which these obstructions occasion does not reach back to the sluice, the efflux is not affected by it.—Even when it does reach to the sluice, there will be a less depth immediately behind it than farther down the canal, where it is in train; because the swift moving water which is next the bottom drags with it the regorged water which lies on it: but the canal must be rapid to make this difference of depth sensible. In ordinary canals, with moderate slopes and velocities, the velocity at the sluice may be safely taken as if it were that which corresponds to the difference of depths above and below the sluice, where both were in train.

Let therefore H be the depth above the sluice, and h the depth in the canal. Let e be the elevation of the sluice above the sole, and let b be its breadth. The discharge will be $e\,b\sqrt{H-h}\sqrt{2\,G}$ for the sluice, and $w\,h\frac{\sqrt{N\,g}}{\sqrt{s}}\sqrt{\frac{w\,h}{w+2\,h}}$ for the canal. These must be the same. This gives the equation $e\,b\sqrt{H-h}\sqrt{2\,G} = w\,h\frac{\sqrt{N\,g}}{\sqrt{s}}\sqrt{\frac{w\,h}{w+2\,h}}$ containing the solution of all the questions which can be proposed. The only uncertainty is in the quantity G, which expresses the velocity competent to the passage of the water through the orifice, circumstanced as it is, namely, subjected to contraction. This may be regulated by a proper form given to the entry into this orifice. The contraction may be almost annihilated by making the masonry of a cycloidal form on both sides, and also at the lower edge of the sluice-board, so as to give the orifice a form resembling fig. 5. D, in the article RIVERS. If the sluice is thin in the face of a bason, the contraction will reduce 2 G to 296. If the sluice be as wide as the canal, 2 G will be nearly 500.

Question 4. Given the head of water in the bason H, the breadth b, and the elevation e of the sluice, and the breadth w and slope s of the canal, to find the depth h of the stream, the velocity, and the discharge?

We must (as in *Question* 2.) make a first supposition for h, in order to find the proper value of d. Then the equation $e\,b\sqrt{H-h}\sqrt{2\,G} = w\,h\frac{\sqrt{N\,g}}{\sqrt{s}}$ gives $h = \frac{G\,e^2\,b^2\,s}{w^2\,N\,g\,d} + \sqrt{\frac{G\,e^2\,b^2\,s\,H}{w^2\,N\,g\,d} + \left(\frac{G\,e^2\,b^2\,s}{w^2\,N\,g\,d}\right)^2}$. If this value shall differ considerably from the one which we assumed in order to begin the computation, make use of it for obtaining a new value of d, and repeat the operation. We shall rarely be obliged to perform a third operation.

The following is of frequent use:

Question 5. Given the dimensions and the slope, with the velocity and discharge of a river in its ordinary state, required the area or section of the sluice which will raise the waters to a certain height, still allowing the same quantity of water to pass through? Such an operation may render the rivers navigable for small craft or rafts above the sluice.

The problem is reduced to the determination of the size of orifice which will discharge this water with a velocity competent to the height to which the river is to be raised; only we must take into consideration the velocity of the water above the sluice, considering it as produced by a fall which makes a part of the height productive of the whole velocity at the sluice. Therefore H, in our investigation, must consist of the height to which we mean to raise the waters, and the height which will produce the velocity with which the waters approach the sluice: h, or the depth of the stream, is the ordinary depth of the river. Then (using the former symbols) we have $e\,b\,\frac{w\,h\sqrt{N\,g\,d}}{\sqrt{2\,G\,s\,(H-h)}}, = \frac{Q}{\sqrt{2\,G\,(H-h)}}$.

If the area of the sluice is known, and we would learn the height to which it will raise the river, we have $H-h = \frac{Q^2}{2\,G\,e^2\,b^2}$ for the expression of the rise of the

water

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water above its ordinary level. But from this we must take the height which would produce the velocity of the river; so that if the sluice were as wide as the river, and were raised to the ordinary surface of the water, $\frac{Q^2}{2 G e^2 b^2}$, which expresses the height that produces the velocity under the sluice, must be equal to the depth of the river, and H—h will be =0.

The performance of aqueduct drains is a very important thing, and merits our attention in this place. While the art of managing waters, and of conducting them so as to answer our demands, renders us very important service by embellishing our habitations, or promoting our commercial intercourse, the art of draining creates as it were new riches, fertilizing tracts of bog or marsh, which was not only useless, but hurtful by its unwholesome exhalations, and converting them into rich pastures and gay meadows. A wild country, occupied by marshes which are inaccessible to herds or flocks, and serve only for the haunts of water-fowls, or the retreat of a few poor fishermen, when once it is freed from the waters in which it is drowned, opens its lap to receive the most precious seeds, is soon clothed in the richest garb, gives life and abundance to numerous herds, and never fails to become the delight of the industrious cultivator who has enfranchised it, and is attached to it by the labour which it cost him. In return, it procures him abundance, and supplies him with the means of daily augmenting its fertility. No species of agriculture exhibits such long-continued and progressive improvement. New families flock to the spot, and there multiply; and there nature seems the more eager to repay their labours, in proportion as she has been obliged, against her will, to keep her treasures locked up for a longer time, chilled by the waters. The countries newly inhabited by the human race, as is a great part of America, especially to the southward, are still covered to a great extent with marshes and lakes; and they would long remain in this condition, if population, daily making new advances, did not increase industry, by multiplying the cultivating hands, at the same time that it increases their wants. The Author of this beautiful world has at the beginning formed the great masses of mountain, has scooped out the dales and sloping hills, has traced out the courses, and even formed the beds of the rivers: but he has left to man the care of making his place of abode, and the field which must feed him, dry and comfortable. For this task is not beyond his powers, as the others are. Nay, by having this given to him in charge, he is richly repaid for his labour by the very state in which he finds those countries into which he penetrates for the first time. Being covered with lakes and forests, the juices of the soil are kept for him as it were in reserve. The air, the burning heat of the sun, and the continual washing of rains, would have combined to expend and dissipate their vegetative powers, had the fields been exposed in the same degree to their action as the inhabited and cultivated countries, the most fertile moulds of which are long since lodged in the bottom of the ocean. All this would have been completely lost through the whole extent of South America, had it not been protected by the forests which man must cut down, by the rank herbage which he must burn, and by the marsh and bog which he must destroy by draining. Let not ungrateful man complain of this. It is his duty to take on himself the task of opening up treasures, preserved on purpose for him with so much judgment and care. If he has discernment and sensibility, he will even thank the Author of all good, who has thus husbanded them for his use. He will co-operate with his beneficent views, and will be careful not to proceed by wantonly snatching at present any partial good, and by picking out what is most easily got at, regardless of him who is to come afterwards to uncover and extract the remaining riches of the ground. A wise administration of such a country will think it their duty to leave a just share of this inheritance to their descendants, who are entitled to expect it as the last legatees. National plans of cultivation should be formed on this principle, that the steps taken by the present cultivators for realizing part of the riches of the infant country shall not obstruct the works which will afterwards be necessary for also obtaining the remainder. This is carefully attended to in Holland and in China. No man is allowed to conduct the drains, by which he recovers a piece of marsh, in such a way as to render it much more difficult for a neighbour, or even for his own successor, to drain another piece, although it may at present be quite inaccessible. There remain in the middle of the most cultivated countries many marshes, which industry has not yet attempted to drain, and where the legislature has not been at pains to prevent many little abuses which have produced elevations in the beds of rivers, and rendered the complete draining of some spots impossible. Administration should attend to such things, because their consequences are great. The sciences and arts, by which alone these difficult and costly jobs can be performed, should be protected, encouraged, and cherished. It is only from science that we can obtain principles to direct these arts. The problem of draining canals is one of the most important, and yet has hardly ever occupied the attention of the hydraulic speculatist. We apprehend that M. Buat's theory will throw great light on it; and regret that the very limited condition of our present work will hardly afford room for a slight sketch of what may be done on the subject. We shall, however, attempt it by a general problem, which will involve most of the chief circumstances which occur in works of that kind.

Quest. 6. Let the hollow ground A (fig. 2.) be inundated by rains or springs, and have no outlet but the canal AB, by which it discharges its water into the neighbouring river BCDE, and that its surface is nearly on a level with that of the river at D. It can only drain when the river sinks in the droughts of summer; and even if it could then drain completely, the putrid marsh would only be an infecting neighbour. It may be proposed to drain it by one or more canals; and it is required to determine their lengths and other dimensions, so as to produce the best effects?

It is evident that there are many circumstances to determine the choice, and many conditions to be attended to.

If the canals AC, AD, AG, are respectively equal to the proportions BC, BD, BF, of the river, and have the same slopes, they will have the same discharge; but they are not for this reason equivalent. The long canal AE may drain the marsh completely, while the short

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one AC will only do it in part; because the difference of level between A and C is but inconsiderable. Also the freshes of the river may totally obstruct the operation of AC, while the canal AE cannot be hurt by them, E being so much lower than C. Therefore the canal must be carried so far down the river, that no freshes there shall ever raise the waters in the canal so high as to reduce the slope in the upper part of it to such a level that the current shall not be sufficient to carry off the ordinary produce of water in the marsh.

Still the problem is indeterminate, admitting many solutions. This requisite discharge may be accomplished by a short but wide canal, or by a longer and narrower. Let us first see what solution can be made, so as to accomplish our purpose in the most economical manner, that is, by means of the smallest equation.—We shall give the solution in the form of an example.

Suppose that the daily produce of rains and springs raises the water $1\frac{1}{2}$ inch on an area of a square league, which gives about 120,000 cubic fathoms of water. Let the bottom of the bason be three feet below the surface of the freshes in the river at B in winter. Also, that the slope of the river is 2 inches in 100 fathoms, or $\frac{1}{3600}$dth, and that the canal is to be 6 feet deep.

The canal being supposed nearly parallel to the river, it must be at least 1800 fathoms long before it can be admitted into the river, otherwise the bottom of the bog will be lower than the mouth of the canal; and even then a hundred or two more fathoms added to this will give it so little slope, that an immense breadth will be necessary to make the discharge with so small a velocity. On the other hand, if the slope of the canal be made equal to that of the river, an extravagant length will be necessary before its admission into the river, and many obstacles may then intervene. And even then it must have a breadth of 13 feet, as may easily be calculated by the general hydraulic theorem. By receding from each of these extremes, we shall diminish the expence of excavation. Therefore,

Let x and y be the breadth and length, and h the depth (6 feet), of the canal. Let q be the depth of the bog below the surface of the river, opposite to the bason, D the discharge in a second, and $\frac{1}{a}$ the slope of the river. We must make $h\,x\,y$ a minimum, or $x\dot{y}+y\dot{x}=0$.

The general formula gives the velocity

$$V=\frac{\sqrt{n\,g}\,(\sqrt{d}-0{,}1)}{\sqrt{s}-L\sqrt{s+1{,}6}}-0{,}3(\sqrt{d}-0{,}1).$$ This would give x and y; but the logarithmic term renders it very complicated. We may make use of the simple form $V=\frac{\sqrt{N\,g\,d}}{\sqrt{S}}$, making $\sqrt{n\,g}$ nearly $2\,y\,b$. This will be sufficiently exact for all cases which do not deviate far from this, because the velocities are very nearly in the subduplicate ratio of the slopes.

To introduce these data into the equation, recollect that $V=\frac{D}{h\,x}$; $d=\frac{h\,x}{x+2\,h}$. As to S, recollect that the canal being supposed of nearly equal length with the river, $\frac{y}{a}$ will express the whole difference of height, and $\frac{y}{a}-q$ is the difference of height for the canal. This quantity being divided by y, gives the value of $\frac{1}{S}=\frac{\frac{y}{a}-q}{y}$. Therefore the equation for the canal becomes $\sqrt{N\,g}\sqrt{\frac{h\,x}{x+2\,h}}\sqrt{\frac{\frac{y}{a}-q}{y}}$. Hence we deduce

$$y=\frac{N\,g\,q\,h^3x^3}{\frac{N\,g\,h^3x^3}{a}-D^2(x+2h)}\text{ and }\dot{y}=\frac{3\,N\,g\,q\,h^3x^2\dot{x}}{\frac{N\,g\,h^3x^3}{a}-D^2(x+2h)}$$

$$-\frac{N\,g\,q\,h^3x^3\dot{x}\left(\frac{3\,N\,g\,h^3\,x^2}{a}-D^2\right)}{\left(\frac{N\,g\,h^3\,x^3}{a}-D^2\,(x+2\,h)\right)^2}.$$ If we substitute these values in the equation $y\,\dot{x}+x\,\dot{y}=0$, and reduce it, we obtain finally,

$$\frac{N\,g\,h^3\,x^3}{a\,D^2}-3\,x=8\,h.$$

If we resolve this equation by making $N\,g=(296)^2$, or 87616 inches; $h=72$, $\frac{1}{a}=\frac{1}{3600}$, and $D=518400$, we obtain $x=392$ inches, or 32 feet 8 inches, and $\frac{D}{hx}$, or $V=18{,}36$ inches. Now putting these values in the exact formula for the velocity, we obtain the slope of the canal, which is $\frac{1}{11664}$, nearly 0,62, inches in 100 fathoms.

Let l be the length of the canal in fathoms. As the river has 2 inches fall in 100 fathoms, the whole fall is $\frac{2\,l}{100}$, and that of the canal is $\frac{0{,}62\,l}{100}$. The difference of these two must be 3 feet, which is the difference between the river and the entry of the canal. We have therefore $\left(\frac{2-0.62}{100}\right)\,l=36$ inches. Hence $l=2604$ fathoms; and this multiplied by the section of the canal gives 14177 cubic fathoms of earth to be removed.

This may surely be done, in most cases, for eight shillings each cubic fathom, which does not amount to 6000l. a very moderate sum for completely draining of nine square miles of country.

In order to judge of the importance of this problem, we have added two other canals, one longer and the other shorter, having their widths and slopes so adjusted as to ensure the same performance.

Width. Feet.	Velocity. Inches.	Slope.	Length.	Excavation.
42	14.28	$\frac{1}{18788}$	2221	15547
$32\frac{2}{3}$	18.36	$\frac{1}{11664}$	2604	14177
21	28.57	$\frac{1}{4761}$	7381	15833

We have considered this important problem in its most simple state. If the bason is far from the river, so that the drains are not nearly parallel to it, and therefore have less slope attainable in their course, it is more difficult. Perhaps the best method is to try two very extreme cases and a middle one, and then a fourth, nearer to that extreme which differs least from the middle one in the

the quantity of excavation. This will point out on which side the minimum of excavation lies, and also the law by which it diminishes and afterwards increases. Then draw a line, on which set off from one end the lengths of the canals. At each length erect an ordinate representing the excavation; and draw a regular curve through the extremities of the ordinates. From that point of the curve which is nearest to the base line, draw another ordinate to the base. This will point out the best length of the canal with sufficient accuracy. The length will determine the slope, and this will give the width, by means of the general theorem. *N. B.* These draining canals must always come off from the bason with evasated entries. This will prevent the loss of much fall at the entry.

Two canals may sometimes be necessary. In this case expence may frequently be saved, by making one canal flow into the other. This, however, must be at such a distance from the bason, that the swell produced in the other by this addition may not reach back to the immediate neighbourhood of the bason, otherwise it would impede the performance of both. For this purpose, recourse must be had to Problem III. in N° 104. of the article RIVER. We must here observe, that in this respect canals differ exceedingly from rivers; rivers enlarge their beds, so as always to convey every increase of waters; but a canal may be gorged through its whole length, and will then greatly diminish its discharge. In order that the lower extremity of a canal may convey the waters of an equal canal admitted into it, their junction must be so far from the bason that the swell occasioned by raising its waters nearly $\frac{2}{7}$ more (viz. in the subduplicate ratio of 1 to 2) may not reach back to the bason.

This observation points out another method of economy. Instead of one wide canal, we may make a narrower one of the whole length, and another narrow one reaching part of the way, and communicating with the long canal at a proper distance from the bason. But the lower extremity will now be too shallow to convey the waters of both. Therefore raise its banks by using the earth taken from its bed, which must at any rate be disposed of. Thus the waters will be conveyed, and the expence, even of the lower part of the long canal, will scarcely be increased.

These observations must suffice for an account of the management of open canals; and we proceed to the consideration of the conduct of water in pipes.

This is much more simple and regular, and the general theorem requires very trifling modifications for adapting it to the cases or questions that occur in the practice of the civil engineer. Pipes are always made round, and therefore d is always $\frac{1}{4}$th of the diameter. The velocity of water in a pipe which is in train, is

$$= V, = \frac{307\ (\sqrt{d}-0{,}1)}{\sqrt{s}-L\sqrt{s+1{,}6}} - 0{,}3(\sqrt{d}-0{,}) \text{ or } = (\sqrt{d} - 0{,}1)\left(\frac{307}{\sqrt{s}-L\sqrt{s+1{,}6}} - 0{,}3\right).$$

The chief questions are the following:

Quest. 1. Given the height H of the reservoir above the place of delivery, and the diameter and length of the pipe, to find the quantity of water discharged in a second.

Let L be the length, and h the fall which would produce the velocity with which the water enters the pipe, and actually flows in it, after overcoming all obstructions. This may be expressed in terms of the velocity by $\frac{V^2}{2G}$, G denoting the acceleration of gravity, corresponding to the manner of entry. When no methods are adopted for facilitating the entry of the water, by a bell-shaped funnel or otherwise, 2 G may be assumed as = 500 inches, or 42 feet, according as we measure the velocity in inches or feet. The slope is $\frac{1}{s}$, $= \frac{H - \frac{V^2}{2G}}{L}$, which must be put into the general formula. This would make it very complicated. We may simplify it by the consideration that the velocity is very small in comparison of that arising from the height H: consequently h is very small. Also, in the same pipe, the resistances are nearly in the duplicate ratio of the velocities when these are small, and when they differ little among themselves. Therefore make $b = \frac{L}{h}$, taking h by guess, a very little less than H. Then compute the mean velocity v corresponding to these data, or take it from the table. If $h + \frac{v^2}{2G}$ be = H, we have found the mean velocity $V = v$. If not, make the following proportion:

$$h : \frac{v^2}{2G} = H - \frac{V^2}{2G} : \frac{V^2}{2G},$$ which is the same with this, $h + \frac{v^2}{2G} : v^2 = H : V^2$, and V^2 is $= \frac{v^2 H}{h + \frac{v^2}{2G}}$,

$$= \frac{v^2 H}{\frac{2G\,h + v^2}{2G}} = \frac{v^2 \cdot 2GH}{v^2 + 2Gh}.$$

If the pipe has any bendings, they must be calculated for in the manner mentioned in the article RIVER, N° 101; and the head of water necessary for overcoming this additional resistance being called $\frac{V^2}{m}$, the last proportion must be changed for

$$h + v^2\left(\frac{1}{2G} + \frac{1}{m}\right) : v^2 = H : V^2.$$

Quest. 2. Given the height of the reservoir, the length of the pipe, and the quantity of water which is to be drawn off in a second; to find the diameter of the pipe which will draw it off?

Let d be considered as $= \frac{1}{4}$th of the diameter, and let $1 : c$ represent the ratio of the diameter of a circle to its circumference. The section of the pipe is $4\,c\,d^2$. Let the quantity of water per second be Q; then $\frac{Q}{4\,c\,d^2}$ is the mean velocity. Divide the length of the pipe by the height of the reservoir above the place of delivery, diminished by a very small quantity, and call the quotient S. Consider this as the slope of the conduit; the general formula now becomes

$$\frac{Q}{4d^2} = \frac{307(\sqrt{d}-0{,}1)}{\sqrt{s}-L\sqrt{s+1{,}06}} - 0{,}3\ (\sqrt{d}-0{,}1), \text{ or}$$

$$\frac{Q}{4cd^2}$$

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$$\frac{Q}{4cd^2}=\frac{307(\sqrt{d}-0,1)}{\sqrt{S}}-0,3\ (\sqrt{d}-0,1).$$ We may neglect the last term in every case of civil practice, and also the small quantity 0,1. This gives the very simple formula,

$$\frac{Q}{4cd^2}=\frac{307\sqrt{d}}{\sqrt{S}}$$

from which we readily deduce

$$d=\left|\frac{Q\sqrt{S}}{4c\times 307}\right|^{\frac{2}{5}}=\left|\frac{Q\sqrt{S}}{3858}\right|^{\frac{2}{5}}$$

This process gives the diameter somewhat too small. But we easily rectify this error by computing the quantity delivered by the pipe, which will differ a little from the quantity proposed. Then observing, by this equation, that two pipes having the same length and the same slope give quantities of water, of which the squares are nearly as the fifth powers of the diameter, we form a new diameter in this proportion, which will be almost perfectly exact.

It may be observed that the height assumed for determining the slope in these two questions will seldom differ more than an inch or two from the whole height of the reservoir above the place of delivery; for in conduits of a few hundred feet long, the velocity seldom exceeds four feet per second, which requires only a head of three inches.

As no inconvenience worth minding results from making the pipes a tenth of an inch or so wider than is barely sufficient, and as this generally is more than the error arising from even a very erroneous assumption of *h*, the answer first obtained may be augmented by one or two-tenths of an inch, and then we may be confident that our conduit will draw off the intended quantity of water.

We presume that every person who assumes the name of engineer knows how to reduce the quantity of water measured in gallons, pints, or other denominations, to cubic inches, and can calculate the gallons, &c. furnished by a pipe of known diameter, moving with a velocity that is measured in inches per second. We farther suppose that all care is taken in the construction of the conduit, to avoid obstructions occasioned by lumps of solder hanging in the inside of the pipes; and, particularly, that all the cocks and plugs by the way have waterways equal to the section of the pipe. Undertakers are most tempted to fail here, by making the cocks too small, because large cocks are very costly. But the employer should be scrupulously attentive to this; because a simple contraction of this kind may be the throwing away of many hundred pounds in a wide pipe, which yields no more water than can pass through the small cock.

The chief obstructions arise from the deposition of sand or mud in the lower parts of pipes, or the collection of air in the upper parts of their bendings. The velocity being always very moderate, such depositions of heavy matters are unavoidable. The utmost care should therefore be taken to have the water freed from all such things at its entry by proper filtration; and there ought to be cleansing plugs at the lower parts of the bendings, or rather a very little way beyond them. When these are opened, the water issues with greater velocity, and carries the depositions with it.

It is much more difficult to get rid of the air which chokes the pipes by lodging in their upper parts. This is sometimes taken in along with the water at the reservoir, when the entry of the pipe is too near the surface. This should be carefully avoided, and it costs no trouble to do so. If the entry of the pipe is two feet under the surface, no air can ever get in. Floats should be placed above the entries, having lids hanging from them, which will shut the pipe before the water runs too low.

But air is also disengaged from spring-water by merely passing along the pipe. When pipes are supplied by an engine, air is very often drawn in by the pumps in a disengaged state. It is also disengaged from its state of chemical union, when the pumps have a suction-pipe of 10 or 12 feet, which is very common. In whatever way it is introduced, it collects in all the upper part of bendings, and chokes the passage, so that sometimes not a drop of water is delivered. Our cocks should be placed there, which should be opened frequently by persons who have this in charge. Desaguliers describes a contrivance to be placed on all such eminences, which does this of itself. It is a pipe with a cock, terminating in a small cistern. The key of the cock has a hollow ball of copper at the end of a lever. When there is no air in the main pipe, water comes out by this discharger, fills the cistern, raises the ball, and thus shuts the cock. But when the bend of the main contains air, it rises into the cistern, and occupies the upper part of it. Thus the floating ball falls down, the cock opens and lets out the air, and the cistern again filling with water, the ball rises, and the cock is again shut.

A very neat contrivance for this purpose was invented by the late Professor Russel of Edinburgh. The cylindrical pipe BCDE (fig. 3.), at the upper end of a bending of the main, is screwed on, the upper end of which is a flat plate perforated with a small hole F. This pipe contains a hollow copper cylinder G, to the upper part of which is fastened a piece of soft leather H. When there is air in the pipe, it comes out by the hole A, and occupies the discharger, and then escapes through the hole F. The water follows, and, rising in the discharger, lifts up the hollow cylinder G, causing the leather H to apply itself to the plate CD, and shut the hole. Thus the air is discharged without the smallest loss of water. Fig. 3.

It is of the most material consequence that there be no contraction in any part of a conduit. This is evident; but it is also prudent to avoid all unnecessary enlargements. For when the conduit is full of water moving along it, the velocity in every section is inversely proportional to the area of the section: it is therefore diminished wherever the pipe is enlarged; but it must again be increased where the pipe contracts. This cannot be without expending force in the acceleration. This consumes part of the impelling power, whether this be a head of water, or the force of an engine. See what is said on this subject in the article PUMPS, N° 83, &c. Nothing is gained by any enlargement; and every contraction, by requiring an augmentation of velocity, employs a part of the impelling force precisely equal to the weight of a column of water whose base is the contracted passage, and whose height is the fall which would produce a velocity equal to this augmentation. This point seems to have been quite overlooked by engineers of the first eminence, and has in many instances ...tly greatly diminished the performance of their best works. It is no less detrimental in open canals; because at every contraction a small fall is required for restoring the velocity lost in the enlargement of the canal, by which the general slope and velocity are diminished. Another point which must be attended to in the conducting of water is, that the motion should not be subsultory, but continuous. When the water is to be driven along a main by the strokes of a reciprocating engine, it should be forced into an air-box, the spring of which may preserve it in motion along the whole subsequent main. If the water is brought to rest at every successive stroke of the piston, the whole mass must again be put in motion through the whole length of the main. This requires the same useless expenditure of power as to communicate this motion to as much dead matter; and this is over and above the force which may be necessary for raising the water to a certain height; which is the only circumstance that enters into the calculation of the power of the pump-engine.

An air-box removes this imperfection, because it keeps up the motion during the returning stroke of the piston. The compression of the air by the active stroke of the piston must be such as to continue the impulse in opposition to the contrary pressure of the water (if it is to be raised to some height), and in opposition to the friction or other resistances which arise from the motion that the water really acquires. Indeed a very considerable force is employed here also in changing the motion of the water, which is forced out of the capacious air-box into the narrow pipe; and when this change of motion is not judiciously managed, the expenditure of power may be as great as if all were brought to rest and again put in motion. It may even be greater, by causing the water to move in the opposite direction to its former motion. Of such consequence is it to have all these circumstances scientifically considered. It is in such particulars, unheeded by the ordinary herd of engineers or pump-makers, that the superiority of an intelligent practitioner is to be seen.

Another material point in the conduct of water in pipes is the distribution of it to the different persons who have occasion for it. This is rarely done from the rising main. It is usual to send the whole into a cistern, from which it is afterwards conducted to different places in separate pipes. Till the discovery of the general theorem by the chevalier Buat, this has been done with great inaccuracy. Engineers think that the different purchasers from water-works receive in proportion to their respective bargains when they give them pipes whose areas are proportional to these payments. But we now see, that when these pipes are of any considerable length, the waters of a larger pipe run with a greater velocity than those of a smaller pipe having the same slope. A pipe of two inches diameter will give much more water than four pipes of one inch diameter; it will give as much as five and a half such pipes, or more; because the squares of the discharges are very nearly as the fifth powers of the diameters. This point ought therefore to be carefully considered in the bargains made with the proprietors of water-works, and the payments made in this proportion. Perhaps the most unexceptionable method would be to make a double distribution. Let the water be first let off in its proper proportions into a second series of small cisterns, and let each have a pipe which will convey the whole water that is discharged into it. The first distribution may be made entirely by pipes of one inch in diameter; this would leave nothing to the calculation of the distributor, for every man would pay in proportion to the number of such pipes which run into his own cistern.

In many cases, however, water is distributed by pipes derived from a main. And here another circumstance comes into action. When water is passing along a pipe, its pressure on the sides of the pipe is diminished by its velocity; and if a pipe is now derived from it, the quantity drawn off is also diminished in the subduplicate ratio of the pressures. If the pressure is reduced to one-fourth, one-ninth, one-sixteenth, &c. the discharge from the lateral pipe is reduced to one-half, one-third, one-fourth, &c.

It is therefore of great importance to determine, what this diminution of pressure is which arises from the motion along the main.

It is plain, that if the water suffered no resistance in the main, its velocity would be that with which it entered, and it would pass along without exerting any pressure. If the pipe were shut at the end, the pressure on the sides would be the full pressure of the head of water. If the head of water remain the same, and the end of the tube be contracted, but not stopped entirely, the velocity in the pipe is diminished. If we would have the velocity in the pipe with this contracted mouth augmented to what it was before the contraction was made, we must employ the pressure of a piston, or of a head of water. This is propagated through the fluid, and thus a pressure is immediately excited on the sides of the pipe. New obstructions of any kind, arising from friction or any other cause, produce a diminution of velocity in the pipe. But when the natural velocity is checked, the particles react on what obstructs their motion; and this action is uniformly propagated through a perfect fluid in every direction. The resistance therefore which we thus ascribe to friction, produces the same lateral pressure, which a contraction of the orifice, which equally diminishes the velocity in the pipe, would do. Indeed this is demonstrable from any distinct notions that we can form of these obstructions. They proceed from the want of perfect smoothness, which obliges the particles next the sides to move in undulated lines. This excites transverse forces in the same manner as any constrained curvilineal motion. A particle in its undulated path tends to escape from it, and acts on the lateral particles in the same manner that it would do if moving singly in a capillary tube having the same undulations; it would press on the concave side of every such undulation. Thus a pressure is exerted among the particles, which is propagated to the sides of the pipe; or the diminution of velocity may arise from a viscidity or want of perfect fluidity. This obliges the particle immediately pressed to drag along with it another particle which is withheld by adhesion to the sides. This requires additional pressure from a piston, or an additional head of water; and this pressure also is propagated to the sides of the pipe.

Hence it should follow, that the pressure which water in motion exerts on the sides of its conduit is equal to that which is competent to the head of water which impels

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impels it into the pipe, diminished by the head of water competent to the actual velocity with which it moves along the pipe. Let H represent the head of water which impels it into the entry of the pipe, and h the head which would produce the actual velocity; then $H-h$ is the column which would produce the pressure exerted on its sides.

This is abundantly verified by very simple experiments. Let an upright pipe be inserted into the side of the main-pipe. When the water runs out by the mouth of the main, it will rise in this branch till the weight of the column balances the pressure that supports it; and if we then ascertain the velocity of the issuing water by means of the quantity discharged, and compute the head or height necessary for producing this velocity, and subtract this from the height of water above the entry of the main, we shall find the height in the branch precisely equal to their difference. Our readers may see this by examining the experiments related by Gravesande, and still better by consulting the experiments narrated by Bossut, § 558. which are detailed with great minuteness; the results corresponded accurately with this proposition. The experiments indeed were not heights of water supported by this pressure, but water expelled by it through the same orifice. Indeed the truth of the proposition appears in every way we can consider the motion of water. And as it is of the first importance in the practice of conducting water (for reasons which will presently appear), it merits a particular attention. When an inclined tube is in train, the accelerating power of the water (or its weight diminished in the proportion of the length of the oblique column to its vertical height, or its weight multiplied by the fraction $\frac{1}{s}$, which expresses the slope), is in equilibrio with the obstructions; and therefore it exerts no pressure on the pipe but what arises from its weight alone. Any part of it would continue to slide down the inclined plane with a constant velocity, though detached from what follows it. It therefore derives no pressure from the head of water which impelled it into the pipe. The same must be said of a horizontal pipe infinitely smooth, or opposing no resistance. The water would move in this pipe with the full velocity due to the head of water which impels it into the entry. But when the pipe opposes an obstruction, the head of water is greater than that which would impel it into the pipe with the velocity that it actually has in it; and this additional pressure is propagated along the pipe, where it is balanced by the actual resistance, and therefore excites a *quaqua versum* pressure on the pipe. In short, whatever part of the head of water in the reservoir, or of the pressure which impels it along the tube, is not employed in producing velocity, is employed in acting against some obstruction, and excites (by the reaction of this obstruction) an equal pressure on the tube. The rule therefore is general, but is subject to some modifications which deserve our attention.

Fig. 4. In the simply inclined pipe BC (fig. 4.) the pressure on any point S is equal to that of the head AB of water which impels the water into the pipe, wanting or *minus* that of the head of water which would communicate to it the velocity with which it actually moves. This we shall call x, and consider it as the weight of a column of water whose length also is x. In like manner H may be the column AB, which impels the water into the pipe, and would communicate a certain velocity; and h may represent the column which would communicate the actual velocity. We have therefore $x = H-h$.

In the pipe HIKL, the pressure at the point I is $AH-h-IO, =H-h-IO$; and the pressure at K is $H-h+PK$.

And in the pipe DEFG, the pressure on E is $=AR-h-EM, =H-h-EM$; and the pressure at F is $H-h+FN$.

We must carefully distinguish this pressure on any square inch of the pipe from the obstruction or resistance which that inch actually exerts, and which is part of the cause of this pressure. The pressure is (by the laws of hydrostatics) the same with that exerted on the water by a square inch of the piston or forcing head of water. This must balance the united obstructions of the whole pipe, in as far as they are not balanced by the relative weight of the water in an enclosed pipe. Whatever be the inclination of a pipe, and the velocity of the water in it, there is a certain part of this resistance which may not be balanced by the tendency which the water has to slide along it, provided the pipe be long enough; or if the pipe is too short, the tendency down the pipe may more than balance all the resistances that obtain below. In the first case, this overplus must be balanced by an additional head of water; and in the latter case the pipe is not in train, and the water will accelerate. There is something in the mechanism of these motions which makes a certain length of pipe necessary for bringing it into train; a certain portion of the surface which acts in concert in obstructing the motion. We do not completely understand this circumstance, but we can form a pretty distinct notion of its mode of acting. The film of water contiguous to the pipe is withheld by the obstruction, but glides along; the film immediately within this is withheld by the outer film, but glides through it: and thus all the concentric films glide within those around them, somewhat like the sliding tubes of a spyglass, when we draw it out by taking hold of the end of the innermost. Thus the second film passes beyond the first or outermost, and becomes the outermost, and rubs along the tube. The third does the same in its turn; and thus the central filaments come at last to the outside, and all sustain their greatest possible obstruction. When this is accomplished, the pipe is in train. This requires a certain length, which we cannot determine by theory. We see, however, that pipes of greater diameter must require a greater length, and this in a proportion which is probably that of the number of filaments, or the square of the diameter. Buat found this supposition agree well enough with his experiments. A pipe of one inch in diameter sustained no change of velocity by gradually shortening it till he reduced it to six feet, and then it discharged a little more water. A pipe of two inches diameter gave a sensible augmentation of velocity when shortened to 25 feet. He therefore says, that the square of the diameter in inches, multiplied by 72, will express (in inches) the length necessary for putting any pipe in train.

The resistance exerted by a square inch of the pipe makes but a small part of the pressure which the whole resistances

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resistances occasion to be exerted there before they can be overcome. The resistance may be represented by $\frac{d}{s}$, when d is the hydraulic depth (one-fourth of the diameter), and s the length of a column whose vertical height is one inch, and it is the relative weight of a column of water whose base is a square inch, and height is d. For the resistance of any length s of pipe which is in train, is equal to the tendency of the water to slide down (being balanced by it); that is, is equal to the weight of this column multiplied by $\frac{1}{s}$. The magnitude of this column is had by multiplying its length by its section. The section is the product of the border b or circumference, multiplied by the mean depth d, or it is $b\,d$. This multiplied by the length, is $b\,d\,s$; and this multiplied by the slope $\frac{1}{s}$ is $b\,d$, the relative weight of the column whose length is s. The relative weight of one inch is therefore $\frac{b\,d}{s}$; and this is in equilibrio with the resistance of a ring of the pipe one inch broad. This, when unfolded, is a parallelogram b inches in length. One inch of this therefore is $\frac{d}{s}$, the relative weight of a column of water having d for its height and a square inch for its base. Suppose the pipe four inches in diameter, and the slope $= 253$, the resistance is one grain; for an inch of water weighs 253 grains.

This knowledge of the pressure of water in motion is of great importance. In the management of rivers and canals it instructs us concerning the damages which they produce in their beds by tearing up the soil; it informs us of the strength which we must give to the banks: but it is of more consequence in the management of close conduits. By this we must regulate the strength of our pipes; by this also we must ascertain the quantities of water which may be drawn off by lateral branches from any main conduit.

With respect to the first of these objects, where security is our sole concern, it is proper to consider the pressure in the most unfavourable circumstances, viz. when the end of the main is shut. This case is not unfrequent. Nay, when the water is in motion, its velocity in a conduit seldom exceeds a very few feet in a second. Eight feet per second requires only one foot of water to produce it. We should therefore estimate the strain on all conduits by the whole height of the reservoir.

In order to adjust the strength of a pipe to the strain, we may conceive it as consisting of two half cylinders of insuperable strength, joined along the two seams, where the strength is the same with the ordinary strength of the materials of which it is made. The inside pressure tends to burst the pipe by tearing open these seams; and each of these two seams is equal to the weight of a column of water whose height is the depth of the seam below the surface of the reservoir, and whose base is an inch broad and a diameter of the pipe in length. This follows from the common principles of hydrostatics.

Suppose the pipe to be of lead, one foot in diameter and 100 feet under the surface of the reservoir. Water weighs $62\frac{1}{2}$ pounds per foot. The base of our column is therefore $\frac{1}{12}$th of a foot, and the tendency to burst the pipe is $100 \times 62\frac{1}{2} \times \frac{1}{12}th=\frac{6250}{12}$, $= 521$ pounds nearly. Therefore an inch of one seam is strained by $260\frac{1}{2}$ pounds. A rod of lead one inch square is pulled asunder by 860 pounds, (see *Strength of Materials*, N° 40.). Therefore if the thickness of the seam is $=\frac{260}{860}$ inches, or one-third of an inch, it will just withstand this strain. But we must make it much stronger than this, especially if the pipe leads from an engine which sends the water along it by starts. Belidor and Desaguliers have given tables of the thickness and weights of pipes which experience has found sufficient for the different materials and depths. Desaguliers says, that a leaden pipe of three-fourths of an inch in thickness is strong enough for a height of 140 feet and diameter of seven inches. From this we may calculate all others. Belidor says, that a leaden pipe 12 inches diameter and 60 feet deep should be half an inch thick: but these things will be more properly computed by means of the list given in N° 40 of the article *Strength of Materials*.

The application which we are most anxious to make of the knowledge of the pressure of moving waters is the derivation from a main conduit by lateral branches. This occurs very frequently in the distribution of waters among the inhabitants of towns; and it is so imperfectly understood by the greatest part of those who take the name of engineers, that individuals have no security that they shall get even one half of the water they bargain and pay for; yet this may be as accurately ascertained as any other problem in hydraulics by means of our general theorem. The case therefore merits our particular attention.

It appears to be determined already, when we have ascertained the pressures by which the water is impelled into these lateral pipes, especially after we have said that the experiments of Bossut on the actual discharges from a lateral pipe fully confirm the theoretical doctrine. But much remains to be considered. We have seen that there is a vast difference between the discharge made through a hole, or even through a short pipe, and the discharge from the far end of a pipe derived from a main conduit. And even when this has been ascertained by our new theory, the discharge thus modified will be found considerably different from the real state of things: For when water is flowing along a main with a known velocity, and therefore exerting a known pressure on the circle which we propose for the entry of a branch, if we insert a branch there water will go along it: but this will generally make a considerable change in the motion along the main, and therefore in the pressure which is to expel the water. It also makes a considerable change in the whole quantity which passes along the anterior part of the main, and a still greater change on what moves along that part of it which lies beyond the branch: it therefore affects the quantity necessary for the whole supply, the force that is required for propelling it, and the quantity delivered by other branches. This part therefore of the management of water in conduits is of considerable importance and intricacy. We can propose in this place nothing more than a solution of such leading questions as involve the chief circumstances, recommending to our readers the perusal of original works on this subject. M. Bossut's experiments

experiments are fully competent to the establishment of the fundamental principle. The hole through which the lateral discharges were made was but a few feet from the reservoir. The pipe was successively lengthened, by which the resistances were increased, and the velocity diminished. But this did not affect the lateral discharges, except by affecting the pressures; and the discharges from the end of the main were supposed to be the same as when the lateral pipe was not inserted. Although this was not strictly true, the difference was insensible, because the lateral pipe had but about the 18th part of the area of the main.

Suppose that the discharge from the reservoir remains the same after the derivation of this branch, then the motion of the water all the way to the insertion of the branch is the same as before; but, beyond this, the discharge is diminished by all that is discharged by the branch, with the head x equivalent to the pressure on the side. The discharge by the lower end of the main being diminished, the velocity and resistance in it are also diminished. Therefore the difference between x and the head employed to overcome the friction in this second case, would be a needless or inefficient part of the whole load at the entry, which is impossible; for every force produces an effect, or it is destroyed by some reaction. The effect of the forcing head of water is to produce the greatest discharge corresponding to the obstructions; and thus the discharge from the reservoir, or the supply to the main, must be augmented by the insertion of the branch, if the forcing head of water remains the same. A greater portion therefore of the forcing head was employed in producing a greater discharge at the entry of the main, and the remainder, less then x, produced the pressure on the sides. This head was the one competent to the obstructions resulting from the velocity beyond the insertion of the branch; and this velocity, diminished by the discharge already made, was less than that at the entry, and even than that of the main without a branch. This will appear more distinctly by putting the case into the form of an equation. Therefore let $H-x$ be the height due to the velocity at the entry, of which the effect obtains only horizontally. The head x is the only one which acts on the sides of the tube, tending to produce the discharge by the branch, at the same time that it must overcome the obstructions beyond the branch. If the orifice did not exist, and if the force producing the velocity on a short tube be represented by $2\,G$, and the section of the main be A, the supply at the entry of the main would be $A\sqrt{2\,G}\sqrt{H-x}$; and if the orifice had no influence on the value of x, the discharge by the orifice would be $D\sqrt{\frac{x}{H}}$, D being its discharge by means of the head H, when the end of the main is shut; for the discharges are in the subduplicate ratio of the heads of water by which they are expelled; and therefore $\sqrt{H} : \sqrt{x} = D : D\sqrt{\frac{x}{H}} (=\delta)$. But we have seen that x must diminish; and we know that the obstructions are nearly as the square roots of the velocities, when these do not differ much among themselves. Therefore calling y the pressure or head which balances the resistances of the main without a branch, while x is the head necessary for the main with a branch, we may institute this proportion, $y : H-y = x \frac{x(H-y)}{y}$; and this 4th term will express the head producing the velocity in the main beyond the branch (as $H-y$ would have done in a main without a branch). This velocity beyond the branch will be $\sqrt{2\,G}\sqrt{\frac{x(H-y)}{y}}$, and the discharge at the end will be $A\sqrt{2\,G}\sqrt{\frac{x(H-y)}{y}}$. If to this we add the discharge of the branch, the sum will be the whole discharge, and therefore the whole supply. Therefore we have the following equation, $A\sqrt{2\,G}\sqrt{H-y} = A\sqrt{2G}\sqrt{\frac{x(H-y)}{y}} + D\sqrt{\frac{x}{H}}$. From this we deduce the value of x

$$= \frac{2GHA^2}{\left(A\sqrt{2\,G}\sqrt{\frac{H-y}{y}} + \frac{D}{\sqrt{H}}\right)^2 + 2GA^2}.$$

This value of x being substituted in the equation of the discharge δ of the branch, which was $= D\sqrt{\frac{x}{H}}$, will give the discharges required, and they will differ so much the more from the discharges calculated according to the simple theory, as the velocity in the main is greater. By the simple theory, we mean the supposition that the lateral discharges are such as would be produced by the head $H-h$, where H is the height of the reservoir, and h the head due to the actual velocity in the main.

And thus it appears that the proportion of the discharge by a lateral pipe from a main that is shut at the far end, and the discharge from a main that is open, depends not only on the pressures, but also on the size of the lateral pipe, and its distance from the reservoir. When it is large, it greatly alters the train of the main, under the same head, by altering the discharge at its extremity, and the velocity in it beyond the branch; and if it be near the reservoir, it greatly alters the train, because the diminished velocity takes place through a greater extent, and there is a greater diminution of the resistances.

When the branch is taken off at a considerable distance from the reservoir, the problem becomes more complicated, and the head x is resolved into two parts; one of which balances the resistance in the first part of the main, and the other balances the resistances beyond the lateral pipe, with a velocity diminished by the discharge from the branch.—A branch at the end of the main produces very little change in the train of the pipe.

When the lateral discharge is great, the train may be so altered, that the remaining part of the main will not run full, and then the branch will not yield the same quantity. The velocity in a very long horizontal tube may be so small (by a small head of water and great obstructions in a very long tube) that it will just run full. An orifice made in its upper side will yield nothing; and yet a small tube inserted into it will carry a column almost as high as the reservoir. So that we cannot judge in all cases of the pressures by the discharges, and *vice versa*.

If

If there be an inclined tube, having a head greater than what is competent to the velocity, we may bring it into train by an opening on its upper side near the reservoir. This will yield some water, and the velocity will diminish in the tube till it is in train. If we should now enlarge the hole, it will yield no more water than before.

And thus we have pointed out the chief circumstances which affect these lateral discharges. The discharges are afterwards modified by the conduits in which they are conveyed to their places of destination. These being generally of small dimensions, for the sake of economy, the velocity is much diminished. But, at the same time, it approaches nearer to that which the same conduit would bring directly from the reservoir, because its small velocity will produce a less change in the train of the main conduit.

We should now treat of jets of water, which still make an ornament in the magnificent pleasure grounds of the wealthy. Some of these are indeed grand objects, such as the two at Peterhoff in Russia, which spout about 60 feet high a column of nine inches diameter, which falls again, and shakes the ground with its blow. Even a spout of an inch or two inches diameter, lancing to the height of 150 feet, is a gay object, and greatly enlivens a pleasure ground; especially when the changes of a gentle breeze bend the jet to one side. But we have no room left for treating this subject, which is of some nicety; and must conclude this article with a very short account of the management of water as an active power for impelling machinery.

II. *Of Machinery driven by Water.*

This is a very comprehensive article, including almost every possible species of mill. It is no less important, and it is therefore matter of regret, that we cannot enter into the detail which it deserves. The mere description of the immense variety of mills which are in general use, would fill volumes, and a scientific description of their principles and maxims of construction would almost form a complete body of mechanical science. But this is far beyond the limits of a work like ours. Many of these machines have been already described under their proper names, or under the articles which give an account of their manufactures; and for others we must refer our readers to the original works, where they are described in minute detail. The great academical collection *Des Arts et Metiers*, published in Paris in many folio volumes, contains a description of the peculiar machinery of many mills; and the volumes of the *Encyclopédie Methodique*, which particularly relate to the mechanic arts, already contain many more. All that we can do in this place is, to consider the chief circumstances that are common to all water-mills, and from which all must derive their efficacy. These circumstances are to be found in the manner of employing water as an acting power, and most of them are comprehended in the construction of water-wheels. When we have explained the principles and the maxims of construction of a water-wheel, every reader conversant in mechanics knows, that the axis of this wheel may be employed to transmit the force impressed on it to any species of machinery. Therefore nothing subsequent to this can with propriety be considered as *water-works*.

Water-wheels are of two kinds, distinguished by the manner in which water is made an impelling power, viz. by its weight, or by its impulse. This requires a very different form and manner of adaptation; and this forms an ostensible distinction, sufficiently obvious to give a name to each class. When water is made to act by its weight, it is delivered from the spout as high on the wheel as possible, that it may continue long to press it down: but when it is made to strike the wheel, it is delivered as low as possible, that it may have previously acquired a great velocity. And thus the wheels are said to be OVERSHOT or UNDERSHOT.

Of Overshot Wheels.

This is nothing but a frame of open buckets, so disposed round the rim of a wheel as to receive the water delivered from a spout; so that one side of the wheel is loaded with water, while the other is empty. The consequence must be, that the loaded side must descend. By this motion the water runs out of the lower buckets, while the empty buckets of the rising side of the wheel come under the spout in their turn, and are filled with water.

If it were possible to construct the buckets in such a manner as to remain completely filled with water till they come to the very bottom of the wheel, the pressure with which the water urges the wheel round its axis would be the same as if the extremity of the horizontal radius were continually loaded with a quantity of water sufficient to fill a square pipe, whose section is equal to that of the bucket, and whose length is the diameter of the wheel. For let the buckets BD and EF (fig. 5.) Fig. 5.
be compared together, the arches DB and EF are equal. The mechanical energy of the water contained in the bucket EF, or the pressure with which its weight urges the wheel, is the same as if all this water were hung on that point T of the horizontal arm CF, where it is cut by the vertical or plumb-line BT. This is plain from the most elementary principles of mechanics. Therefore the effect of the bucket BD is to that of the bucket EF as CT to CF or CB. Draw the horizontal lines PB $b\,b$, QD $d\,d$. It is plain, that if BD is taken very small, so that it may be considered as a straight line, $BD : BO = CB : BP$, and $EF : b\,d = CF : CT$, and $EF \times CT = b\,d \times CF$. Therefore if the prism of water, whose vertical section is $b\,b\,d\,d$, were hung on at F, its force to urge the wheel round would be the same as that of the water lying in the bucket BD. The same may be said of every bucket; and the effective pressure of the whole ring of water AfHKFI, in its natural situation, is the same with the pillar of water $a\,h\,h\,a$ hung on at F. And the effect of any portion BF of this ring is the same with that of the corresponding portion b F$f$$b$ of the vertical pillar. We do not take into account the small difference which arises from the depth B or Ff, because we may suppose the circle described through the centres of gravity of the buckets. And in the farther prosecution of this subject, we shall take similar liberties, with the view of simplifying the subject, and saving time to the reader.

But such a state of the wheel is impossible. The bucket at the very top of the wheel may be completely filled with water; but when it comes into the oblique position BD, a part of the water must run over the outer edge δ, and the bucket will only retain the quantity

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tity ZBD 3; and if the buckets are formed by partitions directed to the axis of the wheel, the whole water must be run out by the time that they descend to the level of the axis. To prevent this many contrivances have been adopted. The wheel has been surrounded with a hoop or sweep, consisting of a circular board, which comes almost into contact with the rim of the wheel, and terminates at H, where the water is allowed to run off. But unless the work is executed with uncommon accuracy, the wheel made exactly round, and the sweep exactly fitting it, a great quantity of water escapes between them; and there is a very sensible obstruction to the motion of such a wheel, from something like friction between the water and the sweep. Frost also effectually stops the motion of such a wheel. Sweeps have therefore been generally laid aside, although there are situations where they might be used with good effect.

Mill-wrights have turned their whole attention to the giving a form to the buckets which shall enable them to retain the water along a great portion of the circumference of the wheel. It would be endless to describe all these contrivances; and we shall therefore content ourselves with one or two of the most approved. The intelligent reader will readily see that many of the circumstances which concur in producing the ultimate effect (such as the facility with which the water is received into the buckets, the place which it is to occupy during the progress of the bucket from the top to the bottom of the wheel, the readiness with which they are evacuated, or the chance that the water has of being dragged beyond the bottom of the wheel by its adhesion, &c. &c.) are such as do not admit of precise calculation on reasoning about their merits; and that this or that form can seldom be evidently demonstrated to be the very best possible. But, at the same time, he will see the general reasons of preference, and his attention will be directed to circumstances which must be attended to, in order to have a good bucketed wheel.

Fig. 6.

Fig. 6. is the outline of a wheel having 40 buckets. The ring of board contained between the concentric circles QDS and PAR, making the ends of the buckets, is called the SHROUDING, in the language of the art, and QP is called the *depth of shrouding*. The inner circle PAR is called the SOLE of the wheel, and usually consists of boards nailed to strong wooden rings of compass timber of considerable scantling, firmly united with the ARMS or radii. The partitions, which determine the form of the buckets, consist of three different planes or boards AB, BC, CD, which are variously named by different artists. We have heard them named the START or SHOULDER, the ARM, and the WREST (probably for wrist, on account of a resemblance of the whole line to the human arm); B is also called the ELBOW. Fig. 7. represents a small portion of the same bucketing on a larger scale, that the proportions of the parts may be more distinctly seen. AG, the sole of one bucket, is made about $\frac{1}{4}$th more than the depth GH of the shrouding. The start AB is $\frac{1}{3}$ of AI. The plane BC is so inclined to AB that it would pass through H; but it is made to terminate in C, in such a manner that FC is $\frac{5}{12}$ths of GH or AI. Then CD is so placed that HD is about $\frac{1}{3}$th of IH.

Fig. 7.

By this construction, it follows that the area FABC is very nearly equal to DABC; so that the water which will fill the space FABC will all be contained in the bucket when it shall come into such a position that AD is a horizontal line; and the line AB will then make an angle of nearly 35° with the vertical, or the bucket will be 35° from the perpendicular. If the bucket descend so much lower that one half of the water runs out, the line AB will make an angle of 25°, or 24° nearly, with the vertical. Therefore the wheel, filled to the degree now mentioned will *begin* to lose water at about $\frac{1}{8}$th of the diameter from the bottom, and *half of the water will be discharged* from the lowest bucket, about $\frac{1}{22}$th of the diameter farther down. These situations of the discharging bucket are marked at T and V in fig. 6. Had a greater proportion of the buckets been filled with water when they were under the spout, the discharge would have begun at a greater height from the bottom, and we should lose a greater portion of the whole fall of water. The loss by the present construction is less than $\frac{1}{10}$th (supposing the water to be delivered into the wheel at the very top), and may be estimated at about $\frac{1}{12}$th; for the loss is the versed sine of the angle which the radius of the bucket makes with the vertical. The versed sine of 35° is nearly $\frac{1}{5}$th of the radius (being 0.18085), or $\frac{1}{10}$th of the diameter. It is evident, that if only $\frac{1}{2}$ of this water were supplied to each bucket as it passes the spout, it would have been retained for 10° more of a revolution, and the loss of fall would have been only about $\frac{1}{14}$th.

These observations serve to show, in general, that an advantage is gained by having the buckets so capacious that the quantity of water which each can receive as it passes the spout may not nearly fill it. This may be accomplished by making them of a sufficient length, that is, by making the wheel sufficiently broad between the two shroudings. Economy is the only objection to this practice, and it is generally very ill placed. When the work to be performed by the wheel is great, the addition of power gained by a greater breadth will soon compensate for the additional expence.

The third plane CD is not very frequent; and mill-wrights generally content themselves with continuing the board all the way from the elbow B to the outer edge of the wheel at H; and AB is generally no more than one-third of the depth AI. But CD is a very evident improvement, causing the wheel to retain a very sensible addition to the water. Some indeed make this addition more considerable, by bringing BC more outward, so as to meet the rim of the wheel at H, for instance, and making HD coincide with the rim. But this makes the entry of the water somewhat more difficult during the very short time that the opening of the bucket passes the spout. To facilitate this as much as possible, the water should get a direction from the spout, such as will send it into the buckets in the most perfect manner. This may be obtained by delivering water through an aperture that is divided by thin plates of board or metal, placed in the proper position, as we have represented in fig. 6. The form of bucket last mentioned, having the wrest concentric with the rim, is unfavourable to the ready admission of the water; whereas an oblique wrest conducts the water which has missed one bucket into the next below.

The mechanical consideration of this subject also shows us, that a deep shrouding, in order to make a capacious bucket,

bucket, is not a good method: it does not make the buckets retain their water any longer; and it diminishes the effective fall of water: for the water received at the top of the wheel immediately falls to the bottom of the bucket, and thus shortens the fictitious pillar of water, which we showed to be the measure of the effective or useful pressure on the wheel: and this concurs with our former reasons for recommending as great a breadth of the wheel, and length of buckets, as economical considerations will permit.

A bucket wheel was some time ago executed by Mr Robert Burns, at the cotton mills of Houston, Burns, and Co. at Cartside in Renfrewshire, of a construction entirely new, but founded on a good principle, which is susceptible of great extension. It is represented in fig. 8. The bucket consists of a start AB, an arm BC, and a wrest CD, concentric with the rim. But the bucket is also divided by a partition LM, concentric with the sole and rim, and so placed as to make the inner and outer portions of nearly equal capacity. It is evident, without any farther reasoning about it, that this partition will enable the bucket to retain its water much longer. When they are filled one-third, they retain the whole water at 18° from the bottom; and they retain one half at 11°. They do not admit the water quite so freely as buckets of the common construction; but by means of the contrivance mentioned a little ago for the spout (also the invention of Mr Burns, and furnished with a rack-work, which raised or depressed it as the supply of water varied, so as at all times to employ the whole fall of the water), it is found, that a slow-moving wheel allows one-half of the water to get into the inner buckets, especially if the partition do not altogether reach the radius drawn through the lip D of the outer bucket.

This is a very great improvement of the bucket wheel; and when the wheel is made of a liberal breadth, so that the water may be very shallow in the buckets, it seems to carry the performance as far as it can go. Mr Burns made the first trial on a wheel of 24 feet diameter; and its performance is manifestly superior to that of the wheel which it replaced, and which was a very good one. It has also another valuable property: When the supply of water is very scanty, a proper adjustment of the apparatus in the spout will direct almost the whole of the water into the outer buckets; which, by placing it at a greater distance from the axis, makes a very sensible addition to its mechanical energy.

We said that this principle is susceptible of considerable extension; and it is evident that two partitions will increase the effect, and that it will increase with the number of partitions: so that when the practice now begun, of making water-wheels of iron, shall become general, and therefore very thin partitions are used, their number may be greatly increased without any inconvenience: and it is obvious, that this series of partitions must greatly contribute to the stiffness and general firmness of the whole wheel.

There frequently occurs a difficulty in the making of bucket wheels, when the half-taught mill-wright attempts to retain the water a long time in the buckets. The water gets into them with a difficulty which he cannot account for, and spills all about, even when the buckets are not moving away from the spout. This arises from the air, which must find its way out to admit the water, but is obstructed by the entering water, and occasions a great spluttering at the entry. This may be entirely prevented by making the spout considerably narrower than the wheel. This will leave room at the two ends of the buckets for the escape of the air. This obstruction is vastly greater than one would imagine; for the water drags along with it a great quantity of air, as is evident in the *Water-blast* described by many authors.

There is another and very serious obstruction to the motion of an overshot or bucketed wheel. When it moves in back water, it is not only resisted by the water, when it moves more slowly than the wheel, which is very frequently the case, but it lifts a great deal in the rising buckets. In some particular states of back water, the descending bucket fills itself completely with water; and, in other cases, it contains a very considerable quantity, and air of common density; while in some rarer cases it contains less water, with air in a condensed state. In the first case, the rising bucket must come up filled with water, which it cannot drop till its mouth get out of the water. In the second case, part of the water goes out before this; but the air rarefies, and therefore there is still some water dragged or lifted up by the wheel, by suction as it is usually called. In the last case there is no such back load on the rising side of the wheel, but (which is as detrimental to its performance) the descending side is employed in condensing air; and although this air aids the ascent of the rising side, it does not aid it so much as it impedes the descending side, being (by the form of the bucket) nearer to the vertical line drawn through the axis.

All this may be completely prevented by a few holes made in the start of each bucket. Air being at least 800 times rarer than water, will escape through a hole almost 30 times faster with the same pressure. Very moderate holes will therefore suffice for this purpose: and the small quantity of water which these holes discharge during the descent of the buckets, produces a loss which is altogether insignificant. The water which runs out of one runs into another, so that there is only the loss of one bucket. We have seen a wheel of only 14 feet diameter working in nearly three feet of back water. It laboured prodigiously, and brought up a great load of water, which fell from it in abrupt dashes, which rendered the motion very hobbling. When three holes of an inch diameter were made in each bucket (12 feet long), the wheel laboured no more, there was no more plunging of water from its rising side, and its power on the machinery was increased more that one-fourth.

These practical observations may contain information that is new even to several experienced mill-wrights. To persons less informed they cannot fail of being useful. We now proceed to consider the action of water thus lying in the buckets of a wheel; and to ascertain its energy as it may be modified by different circumstances of fall, velocity, &c.

With respect to variations in the fall, there can be little room for discussion. Since the active pressure is measured by the pillar of water reaching from the horizontal plane where it is delivered on the wheel, to the horizontal plane where it is spilled by the wheel, it is evident that it must be proportional to this pillar, and therefore we must deliver it as high and retain it as long as possible.

This maxim obliges us, in the first place, to use a wheel

Water-works. wheel whose diameter is equal to the whole fall. We shall not gain any thing by employing a larger wheel; for although we should gain by using only that part of the circumference where the weight will act more perpendicularly to the radius, we shall lose more by the necessity of discharging the water at a greater height from the bottom: For we must suppose the buckets of both the wheels equally well constructed; in which case, the heights above the bottom, where they will discharge the water, will increase in the proportion of the diameter of the wheel. Now, that we shall lose more by this than we gain by the more direct application of the weight, is plain, without any further reasoning, by taking the extreme case, and supposing our wheel enlarged to such a size, that the useless part below is equal to our whole fall. In this case the water will be spilled from the buckets as soon as it is delivered into them. All intermediate cases, therefore, partake of the imperfection of this.

When our fall is exceedingly great, a wheel of an equal diameter becomes enormously big and expensive, and is of itself an unmanageable load. We have seen wheels of 58 feet diameter, however, which worked extremely well; but they are of very difficult construction, and extremely apt to warp and go out of shape by their weight. In cases like this, where we are unwilling to lose any part of the force of a small stream, the best form of a bucket wheel is an inverted chain pump. Instead of employing a chain pump of the best construction, ABCDEA (fig. 9.) to raise water through the upright pipe CB, by means of a force applied to the upper wheel A, let the water be delivered from a spout F, into the upper part of a pipe BC, and it will press down the plugs in the lower and narrower bored part of it with the full weight of the column, and escape at the dead level of C. This weight will urge round the wheel A without any defalcation; and this is the most powerful manner that any fall of water whatever can be applied, and exceeds the most perfect overshot wheel. But though it excels all chains of buckets in economy and in effect, it has all the other imperfections of this kind of machinery. Though the chain of plugs be of great strength, it has so much motion in its joints that it needs frequent repairs; and when it breaks, it is generally in the neighbourhood of A, on the loaded side, and all comes down with a great crash. There is also a loss of power by the immersion of so many plugs and chains in the water; for there can be no doubt but that if the plugs were big enough and light enough, they would buoy and even draw up the plugs in the narrow part at C. They must therefore diminish, in all other cases, the force with which this plug is pressed down.

Fig. 9.

The velocity of an overshot wheel is a matter of very great nicety; and authors, both speculative and practical, have entertained different, nay opposite, opinions on the subject. Mr Belidor, whom the engineers of Europe have long been accustomed to regard as sacred authority, maintains, that there is a certain velocity related to that obtainable by the whole fall, which will procure to an overshot wheel the greatest performance. Desaguliers, Smeaton, Lambert, De Parcieux, and others, maintain, that there is no such relation, and that the performance of an overshot wheel will be the greater, as it moves more slowly by an increase of its load of work. Belidor maintains, that the active power of water lying in a bucket wheel of any diameter is equal to that of the impulse of the same water on the floats of an undershot wheel, when the water issues from a sluice in the bottom of the dam. The other writers whom we have named assert, that the energy of an undershot wheel is but one half of that of an overshot, actuated by the same quantity of water falling from the same height.

To a manufacturing country like ours, which derives astonishing superiority, by which it more than compensates for the impediments of heavy taxes and luxurious living, chiefly from its machinery, in which it leaves all Europe far behind, the decision of this question, in such a manner as shall leave no doubt or misconception in the mind even of an unlettered artist, must be considered as a material service: and we think that this is easily attainable.

When any machine moves uniformly, the accelerating force or pressure actually exerted on the impelled point of the machine is in equilibrio with all the resistances which are exerted at the working point, with those arising from friction, and those that are excited in different parts of the machine by their mutual actions. This is an incontestable truth; and though little attended to by the mechanicians, is the foundation of all practical knowledge of machines. Therefore, when an overshot wheel moves uniformly, with *any velocity whatever*, the water is acting with its whole weight: for gravity would accelerate its descent, if not completely balanced by some reaction; and in this balance gravity and the reacting part of the machine exert equal and opposite pressures, and thus produce the uniform motion of the machine. We are thus particular on this point, because we observe mechanicians of the first name employing a mode of reasoning on the question now before us which is specious, and appears to prove the conclusion which they draw; but is nevertheless contrary to true mechanical principles. They assert, that the slower a heavy body is descending (suppose in a scale suspended from an axis *in peritrocheo*), the more does it press on the scale, and the more does it urge the machine round: and therefore the slower an overshot wheel turns, the greater is the force with which the water urges it round, and the more work will be done. It is very true that the machine is more forcibly impelled, and that more work is done; but this is not because a pound of water presses more strongly, but because there is more water pressing on the wheel; for the spout supplies at the same rate, and each bucket receives more water as it passes by it.

Let us therefore examine this point by the unquestionable principles of mechanics.

Let the overshot wheel A*f*H (fig. 5.) receive the water from a spout at the very top of the wheel; and in order that the wheel may not be retarded by dragging into motion the water simply laid into the uppermost bucket at A, let it be received at B, with the velocity (directed in a tangent to the wheel) acquired by the head of water AP. This velocity, therefore, must be equal to that of the rim of the wheel. Let this be *v*, or let the wheel and the water move over *v* inches in a second. Let the buckets be of such dimensions, that all the water which each receives as it passes the spout is retained till it comes to the position R, where it is discharged at once. It is plain that, in place of the separate quantities of water lying in each bucket, we may substitute a continued ring of water, equal to their sum,

Fig. 5.

sum, and uniformly distributed in the space BER $\varrho f \beta$. This constitutes a ring of uniform thickness. Let the area of its cross section β B and F f be called a. We have already demonstrated, that the mechanical energy with which this water on the circumference of the wheel urges it round, is the same with what would be exerted by the pillar $b\,r\,r\,b$ pressing on Ff, or acting by the lever CF. The weight of this pillar may be expressed by $a \times b\,r$, or $a \times$ PS; and if we call the radius CF of the wheel R, the momentum or mechanical energy of this weight will be represented by $a \times \text{PS} \times \text{R}$.

Now, let us suppose that this wheel is employed to raise a weight W, which is suspended by a rope wound round the axis of the wheel. Let r be the radius of this axle. Then $\text{W} \times r$ is the momentum of the work. Let the weight rise with the velocity u when the rim of the wheel turns with the velocity v, that is, let it rise u inches in a second.

Since a perfect equilibrium obtains between the power and the work when the motion is uniform, we must have $\text{W} \times r = a \times \text{PS} \times \text{R}$. But it is evident that $\text{R} : r = v : u$. Therefore $\text{W} \times u = a \times v \times \text{PS}$.

Now the performance of the machine is undoubtedly measured by the weight and the height to which it is raised in a second, or by $\text{W} \times u$. Therefore the machine is in its best possible state when $a \times v \times \text{PS}$ is a maximum. But it is plain that $a \times v$ is an invariable quantity; for it is the cubic inches of water which the spout supplies in a second. If the wheel moves fast, little water lies in each bucket, and a is small. When v is small, a is great, for the opposite reason; but $a \times v$ remains the same. Therefore we must make PS a maximum, that is, we must deliver the water as high up as possible. But this diminishes AP, and this diminishes the velocity of the wheel: and as this has no limit, the proposition is demonstrated; and an overshot wheel does the more work as it moves slowest.

Convincing as this discussion must be to any mechanician, we are anxious to impress the same maxim on the minds of practical men, unaccustomed to mathematical reasoning of any kind. We therefore beg indulgence for adding a popular view of the question, which requires no such investigation.

We may reason in this way: Suppose a wheel having 30 buckets, and that six cubic feet of water are delivered in a second on the top of a wheel, and discharged without any loss by the way at a certain height from the bottom of the wheel. Let this be the case, whatever is the rate of the wheel's motion; the buckets being of a sufficient capacity to hold all the water which falls into them. Let this wheel be employed to raise a weight of any kind, suppose water in a chain of 30 buckets, to the same height, and with the same velocity. Suppose, farther, that when the load on the rising side of the machine is one half of that on the wheel, the wheel makes four turns in a minute, or one turn in 15 seconds. During this time 90 cubic feet of water have flowed into the 30 buckets, and each has received three cubic feet. Then each of the rising buckets contains $1\frac{1}{2}$ feet; and 45 cubic feet are delivered into the upper cistern during one turn of the wheel, and 180 cubic feet in one minute.

Now, suppose the machine so loaded, by making the rising buckets more capacious, that it makes only two turns in a minute, or one turn in 30 seconds. Then each descending bucket must contain six cubic feet of water. If each bucket of the rising side contained three cubic feet, the motion of the machine would be the same as before. This is a point which no mechanician will controvert. When two pounds are suspended to one end of a string which passes over the pulley, and one pound to the other end, the descent of the two pounds will be the same with that of a four pound weight, which is employed in the same manner to draw up two pounds. Our machine would therefore continue to make four turns in the minute, and would deliver 90 cubic feet during each turn, and 360 in a minute. But, by supposition, it is making but two turns in a minute: this must proceed from a greater load than three cubic feet of water in each rising bucket. The machine must therefore be raising *more* than 90 feet of water during one turn of the wheel, and *more* than 180 in the minute.

Thus it appears, that if the machine be turning twice as slow as before, there is *more than twice the former quantity* in the rising buckets, and more will be raised in a minute by the same expenditure of power. In like manner, if the machine go three times as slow, there must be *more than three times* the former quantity of water in the rising buckets, and more work will be done.

But we may go farther, and assert, that the *more* we retard the machine, by loading it with more work of a similar kind, the greater will be its performance. This does not immediately appear from the present discussion: But let us call the first quantity of water in the rising bucket A; the water raised by four turns in a minute will be $4 \times 30 \times \text{A}, = 120$ A. The quantity in this bucket, when the machine goes twice as slow, has been shown to be greater than 2 A (call it $2\,\text{A} + x$); the water raised by two turns in a minute will be $2 \times 30 \times \overline{2\text{A} + x} = 120\ \text{A} + 60x$. Now, let the machine go four times as slow, making but one turn in a minute, the rising bucket must now contain more than twice $2\,\text{A} + x$, or more than $4\,\text{A} + 2x$; call it $4\,\text{A} + 2x + y$. The work done by one turn in a minute will now be $30 + \overline{4\,\text{A} + 2x + y} = 120\ \text{A} + 60x + 30y$.

By such an induction of the work, done with any rates of motion we choose, it is evident that the performance of the machine increases with every diminution of its velocity that is produced by the mere addition of a similar load of work or that it does the more work the slower it goes.

We have supposed the machine to be in its state of permanent uniform motion. If we consider it only in the beginning of its motion, the result is still more in favour of slow motion: For, at the first action of the moving power, the inertia of the machine itself consumes part of it, and it acquires its permanent speed by degrees; during which, the resistances arising from the work, friction, &c. increase, till they exactly balance the pressure of the water; and after this the machine accelerates no more. Now the greater the power and the resistance arising from the work are, in proportion to the inertia of the machine, the sooner will all arrive at its state of permanent velocity.

There is another circumstance which impairs the performance of an overshot wheel moving with a great velocity, viz. the effects of the centrifugal force on the water

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water in the buckets. Our mill-wrights know well enough, that too great velocity will throw the water out of the buckets; but few, if any, know exactly the diminution of power produced by this cause. The following very simple construction will determine this:

Fig. 10.

Let AOB (fig. 10.) be an overshot wheel, of which AB is the upright diameter, and C is the centre. Make CF the length of a pendulum, which will make two vibrations during one turn of the wheel. Draw FE to the elbow of any of the buckets. The water in this bucket, instead of having its surface horizontal, as NO, will have it in the direction n O perpendicular to FE very nearly.

For the time of falling along half of FC is to that of two vibrations of this pendulum, or to the time of a revolution of the wheel, as the radius of a circle is to its circumference: and it is well known that the time of moving along half of AC, by the uniform action of the centrifugal force, is to that of a revolution as the radius of a circle to its circumference. Therefore the time of describing one half of AC by the centrifugal force, is equal to the time of describing one half of FC by gravity. These spaces, being similarly described in equal times, are proportional to the accelerating forces. Therefore $\frac{1}{2}$ FC : $\frac{1}{2}$ AC, or FC : AC = gravity : centrifugal force. Complete the parallelogram FCEK. A particle at E is urged by its weight in the direction KE, with a force which may be expressed by FC or KE; and it is urged by the centrifugal force in the direction CE, with a force = AC or CE. By their combined action it is urged in the direction FE. Therefore, as the surface of standing water is always at right angles to the action of gravity, that is, to the plumb-line, so the surface of the water in the revolving bucket is perpendicular to the action of the combined force FE.

Let NEO be the position of the bucket, which just holds all the water which it received as it passed the spout when not affected by the centrifugal force; and let NDO be its position when it would be empty. Let the vertical lines through D and E cut the circle described round C with the radius CF in the points H and I. Draw HC, IC, cutting the circle AOB in L and M. Make the arch $\alpha\delta$ equal to AL, and the arch $\alpha\varepsilon$ equal to AM: Then $C\delta$ and $C\varepsilon$ will be the positions of the bucket on the revolving wheel, corresponding to CDO and CEO on the wheel at rest. Water will begin to run out at ε, and it will be all gone at δ.—The demonstration is evident.

The force which now urges the wheel is still the weight *really* in the buckets: For though the water be urged in the direction with the force FE, one of its constitnents, CE, has no tendency to impel the wheel; and KE is the only impelling force.

It is but of late years that mills have been constructed or attended to with that accuracy and scientific skill which are necessary for deducing confidential conclusions from any experiments that can be made with them; and it is therefore no matter of wonder that the opinions of mill-wrights have been so different on this subject. There is a natural wish to see a machine moving briskly; it has the appearance of activity: but a very slow motion always looks as if the machine were overloaded. For this reason mill-wrights have always yielded slowly, and with some reluctance, to the repeated advices of the mathematicians: but they have yieldeé; and we see them adopting maxims of construction more agreeable to sound theory; making their wheels of great breadth, and loading them with a great deal of work. Mr Euler says, that the performance of the best mill cannot exceed that of the worst above $\frac{1}{3}$th: but we have seen a stream of water completely expended in driving a small flax mill, which now drives a cotton mill of 4000 spindles, with all its carding, roving, and drawing machinery, besides the lathes and other engines of the smith and carpenters workshops, exerting a force not less than ten times what sufficed for the flax mill.

The above discussion only demonstrates in general the advantage of slow motion; but does not point out in any degree the relation between the rate of motion and the work performed, nor even the principles on which it depends. Yet this is a subject fit for a mathematical investigation; and we would prosecute it in this place, if it were necessary for the improvement of practical mechanics. But we have seen that there is not, in the nature of things, a maximum of performance attached to any particular rate of motion which should therefore be preferred. For this reason we omit this discussion of mere speculative curiosity. It is very intricate: For we must not now express the pressure on the wheel by a *constant* pillar of water incumbent on the extremity of the horizontal arm, as we did before when we supposed the buckets completely filled; nor by a smaller *constant* pillar, corresponding to a smaller but equal quantity lying in every bucket. Each different velocity puts a different quantity of water into the bucket as it passes the spout; and this occasions a difference in the place where the discharge is begun and completed. This circumstance is some obstacle to the advantages of very slow motions, because it brings on the discharge sooner. All this may indeed be expressed by a simple equation of easy management; but the whole process of the mechanical discussion is both intricate and tedious, and the results are so much diversified by the forms of the buckets, that they do not afford any rule of sufficient generality to reward our trouble. The curious reader may see a very full investigation of this subject in two dissertations by Elvius in the Swedish Transactions, and in the *Hydrodynamique* of Professor Karstner of Gottingen; who has abridged these Dissertations of Elvius, and considerably improved the whole investigation, and has added some comparisons of his deductions with the actual performance of some great works. These comparisons, however, are not very satisfactory. There is also a valuable paper on this subject by Mr Lambert, in the Memoirs of the Academy of Berlin for the year 1775. From these dissertations, and from the *Hydrodynamique* of the abbe Bossut, the reader will get all that theory can teach of the relation between the pressures of the power and work on the machine and the rates of its motion. The practical reader may rest with confidence on the simple demonstration we have given, that the performance is improved by diminishing the velocity.

All we have to do, therefore, is to load the machine, and thus to diminish its speed, unless other physical circumstances throw obstacles in the way: but there are such obstacles. In all machines there are little inequalities of action that are unavoidable. In the action of a wheel and pinion, though made with the utmost judgement and care, there are such inequaities. These increase

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crease by the changes of form occasioned by the wearing of the machine—much greater irregularities arise from the subsultory motions of cranks, stampers, and other parts which move unequally or reciprocally. A machine may be so loaded as just to be in equilibrio with its work, in the favourable position of its parts. When this changes into one less favourable, the machine may stop; if not, it at least staggers, hobbles, or works unequally. The rubbing parts bear long on each other, with enormous pressures, and cut deep, and increase friction. Such slow motions must therefore be avoided. A little more velocity enables the machine to get over those increased resistances by its inertia, or the great quantity of motion inherent in it. Great machines possess this advantage in a superior degree, and will therefore work steadily with a smaller velocity. These circumstances are hardly susceptible of mathematical discussion, and our best reliance is on well-directed experience.

For this purpose, the reader will do well to peruse with care the excellent paper by Mr Smeaton in the Philosophical Transactions for 1759. This dissertation contains a numerous list of experiments, most judiciously contrived by him, and executed with the accuracy and attention to the most important circumstances, which is to be observed in all that gentleman's performances.

It is true, these experiments were made with small models; and we must not, without great caution, transfer the results of such experiments to large works. But we may safely transfer the laws of variation which result from a variation of circumstances, although we must not adopt the absolute quantities of the variations themselves. Mr Smeaton was fully aware of the limitations to which conclusions drawn from experiments on models are subject, and has made the applications with his usual sagacity.

His general inference is, that, in smaller works, the rim of the overshot-wheel should not have a greater velocity than three feet in a second; but that larger mills may be allowed a greater velocity than this. When every thing is executed in the best manner, he says that the work performed will amount to fully two-thirds of the power expended; that is, that three cubic feet of water descending from any height will raise two to the same height.

It is not very easy to compare these deductions with observations on large works; because there are few cases where we have good measures of the resistances opposed by the work performed by the machine. Mills employed for pumping water afford the best opportunities. But the inertia of their working gear diminishes their useful performance very sensibly; because their great beams, pump-rods, &c. have a reciprocating motion, which must be destroyed, and produced anew in every stroke. We have examined some machines of this kind which are esteemed good ones; and we find few of them whose performance exceeds one half of the power expended.

By comparing other mills with these, we get the best information of their resistances. The comparison with mills worked by Watt and Boulton's steam-engines is perhaps a better measure of the resistances opposed by different kinds of work, because their power is very distinctly known. We have been informed by one of the most eminent engineers, that a ton and a half of water per minute falling one foot will grind and dress one bushel of wheat per hour. This is equivalent to 9 tons falling 10 feet.

If an overshot-wheel opposed no resistance, and only one bucket were filled, the wheel would acquire the velocity due to a fall through the whole height. But when it is in this state of accelerated motion, if another bucket of water is delivered into it, its motion must be checked at the first, by the necessity of dragging forward this water. If the buckets fill in succession as they pass the spout, the velocity acquired by an unresisting wheel is but half of that which one bucket would give. In all cases, therefore, the velocity is diminished by the inertia of the entering water when it is simply laid into the upper buckets. The performance will therefore be improved by delivering the water on the wheel with that velocity with which the wheel is really moving. And as we cannot give the direction of a tangent to the wheel, the velocity with which it is delivered on the wheel must be so much greater than the intended velocity of the rim, that it shall be precisely equal to it when it is estimated in the direction of the tangent. Three or four inches of fall are sufficient for this purpose; and it should never be neglected, for it has a very sensible influence on the performance. But it is highly improper to give it more than this, with the view of impelling the wheel by its stroke. For even although it were proper to employ part of the fall in this way (which we shall presently see to be very improper), we cannot procure this impulse; because the water falls among other water, or it strikes the boards of the wheel with such obliquity that it cannot produce any such effect.

It is a much debated question among mill-wrights, Whether the diameter of the wheel should be such as that the water will be delivered at the top of the wheel? or larger, so that the water is received at some distance from the top, where it will act more perpendicularly to the arm? We apprehend that the observations formerly made will decide in favour of the first practice. The space below, where the water is discharged from the wheel, being proportional to the diameter of the wheel, there is an undoubted loss of fall attending a large wheel; and this is not compensated by delivering the water at a greater distance from the perpendicular. We should therefore recommend the use of the whole descending side, and make the diameter of the wheel no greater than the fall, till it is so much reduced that the centrifugal force begins to produce a sensible effect. Since the rim can hardly have a smaller velocity than three feet per second, it is evident that a small wheel must revolve more rapidly. This made it proper to insert the determination that we have given, of the loss of power produced by the centrifugal force. But even with this in view, we should employ much smaller wheels than are generally done on small falls. Indeed the loss of water at the bottom may be diminished, by nicely fitting the arch which surrounds the wheel, so as not to allow the water to escape by the sides or bottom. While this improvement remains in good order, and the wheel entire, it produces a very sensible effect; but the passage widens continually by the wearing of the wheel. A bit of a stick or stone falling in about the wheel tears off part of the shrouding or bucket, and frosty weather frequently binds all fast. It therefore seldom answers expectations. We have nothing to add on this case to

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to what we have already extracted from Mr Smeaton's Dissertation on the Subject of Breast or half Overshot Wheels.

There is another form of wheel by which water is made to act on a machine by its weight, which merits consideration. This is known in this country by the name of *Barker's mill*, and has been described by Desaguliers, vol. ii. p. 460. It consists of an upright pipe or trunk AB (fig. 11.), communicating with two horizontal branches BC, B c, which have a hole C c near their ends, opening in opposite directions, at right angles to their lengths. Suppose water to be poured in at the top from the spout F, it will run out by the holes C and c with the velocity corresponding to the depth of these holes under the surface. The consequence of this must be, that the arms will be pressed backwards; for there is no solid surface at the hole C, on which the lateral pressure of the water can be exerted, while it acts with its full force on the opposite side of the arm. This unbalanced pressure is equal to the weight of a column having the orifice for its base, and twice the depth under the surface of the water in the trunk for its height. This measure of the height may seem odd, because if the orifice were shut, the pressure on it is the weight of a column reaching from the surface. But when it is open, the water issues with nearly the velocity acquired by falling from the surface, and the quantity of motion produced is that of a column of twice this length, moving with this velocity. This is actually produced by the pressure of the fluid, and must therefore be accompanied by an equal reaction.

Fig. 11.

Now suppose this apparatus set on the pivot E, and to have a spindle AD above the trunk, furnished with a cylindrical bobbin D, having a rope wound round it, and passing over a pulley G. A weight W may be suspended there, which may balance this backward pressure. If the weight be too small for this purpose, the retrograde motion of the arms will wind up the cord, and raise the weight; and thus we obtain an acting machine, employing the pressure of the water, and applicable to any purpose. A runner millstone may be put on the top of the spindle; and we should then produce a flour mill of the utmost simplicity, having neither wheel nor pinion, and subject to hardly any wear. It is somewhat surprising, that although this was invented at the beginning of this century, and appears to have such advantage in point of simplicity, it has not come into use. So little has Dr Desaguliers's account been attended to (although it is mentioned by him as an excellent machine, and as highly instructive to the hydraulist), that the same invention was again brought forward by a German professor (Segner) as his own, and has been honoured by a series of elaborate disquisitions concerning its theory and performance by Euler and by John Bernoulli. Euler's Dissertations are to be found in the Memoirs of the Academy of Berlin, 1751, &c. and in the *Nov. Comment. Petropol.* tom. vi. Bernoulli's are at the end of his Hydraulics. Both these authors agree in saying, that this machine excels all other methods of employing the force of water. Simple as it appears, its true theory, and the best form of construction, are most abstruse and delicate subjects; and it is not easy to give such an account of its principles as will be understood by an ordinary reader.

We see, in general, that the machine must press backwards; and little investigation suffices for understanding the intensity of this pressure, when the machine is at rest. But when it is allowed to run backwards, withdrawing itself from the pressure, the intensity of it is diminished; and if no other circumstances intervened, it might not be difficult to say what particular pressure corresponded to any rate of motion. Accordingly, Desaguliers, presuming on the simplicity of the machine, affirms the pressure to be the weight of a column, which would produce a velocity of efflux equal to the difference of the velocity of the fluid and of the machine; and hence he deduces, that its performance will be the greatest possible, when its retrograde velocity is one-third of the velocity acquired by falling from the surface, in which case, it will raise $\frac{8}{27}$ths of the water expended to the same height, which is double of the performance of a mill acted on by the impulse of water.

But this is a very imperfect account of the operation. When the machine (constructed exactly as we have described) moves round, the water which issues descends in the vertical trunk, and then, moving along the horizontal arms, partakes of this circular motion. This excites a centrifugal force, which is exerted against the ends of the arms by the intervention of the fluid. The whole fluid is subjected to this pressure (increasing for every section across the arm in the proportion of its distance from the axis), and every particle is pressed with the accumulated centrifugal forces of all the sections that are nearer to the axis. Every section therefore sustains an actual pressure proportional to the square of its distance from the axis. This increases the velocity of efflux, and this increases the velocity of revolution; and this mutual co-operation would seem to terminate in an infinite velocity of both motions. But, on the other hand, this circular motion must be given anew to every particle of water as it enters the horizontal arm. This can be done only by the motion already in the arm, and at its expence. Thus there must be a velocity which cannot be overpassed even by an unloaded machine. But it is also plain, that by making the horizontal arm very capacious, the motion of the water from the axis to the jet may be made very slow, and much of this diminution of circular motion prevented. Accordingly, Euler has recommended a form by which this is done in the most eminent degree. His machine consists of a hollow conoidal ring, of which fig. 12. is a section. Fig. 12. The part AH h a is a sort of funnel bason, which receives the water from the spout F; not in the direction pointing towards the axis, but in the direction, and with the precise velocity, of its motion. This prevents any retardation by dragging forward the water. The water then passes down between the outer conoid AC c a and the inner conoid HG g h along spiral channels formed by partitions soldered to both conoids. The curves of these channels are determined by a theory which aims at the annihilation of all unnecessary and improper motions of the water, but which is too abstruse to find a place here. The water thus conducted arrives at the bottom CG, c g. On the outer circumference of this bottom are arranged a number of spouts (one for each channel), which are all directed one way in tangents to the circumference.

Adopting the common theory of the reaction of fluids, this should be a very powerful machine, and should raise $\frac{8}{27}$ths of the water expended. But if we admit the reaction

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action to be equal to the force of the issuing fluid (and we do not see how this can be refused), the machine must be nearly twice as powerful. We therefore repeat our wonder, that it has not been brought into use. But it appears that no trial has been made even of a model; so that we have no experiments to encourage an engineer to repeat the trial. Even the late author, Professor Segner, has not related any thing of this kind in his *Exercitationes Hydraulicæ*, where he particularly describes the machine. This remissness probably has proceeded from fixing the attention on Euler's improved construction. It is plain that this must be a most cumbrous mass, even in a small size requiring a prodigious vessel, and carrying an unwieldy load. If we examine the theory which recommends this construction, we find that the advantages, though real and sensible, bear but a small proportion to the whole performance of the simple machine as invented by Dr Barker. It is therefore to be regretted, that engineers have not attempted to realize the first project. We beg leave to recommend it, with an additional argument taken from an addition made to it by Mr Mathon de la Cour, in Rozier's *Journal de Physique*, January and August 1775. This gentleman brings down a large pipe FEH (fig. 13.) from a reservoir, bends it upward at H, and introduces it into two horizontal arms, DA, DB, which have an upright spindle DK, carrying a millstone in the style of Dr Barker's mill. The ingenious mechanician will have no difficulty of contriving a method of joining these pipes, so as to permit a free circular motion without losing much water. The operation of the machine in this form is evident. The water, pressed by the column FG, flows out at the holes A and B, and the unbalanced pressure on the opposite sides of the arms forces them round. The compendiousness and other advantages of this construction are more striking, allowing us to make use of the greatest fall without any increase of the size of the machine, It undoubtedly enables us to employ a stream of water too scanty to be employed in any other form. The author gives the dimensions of an engine which he had seen at Bourg Argental. AB is 92 inches, and its diameter 3 inches; the diameter of each orifice is $1\frac{1}{6}$; FG is 21 feet; the pipe D was fitted into C by grinding; and the internal diameter of D is 2 inches.

Fig. 13.

When the machine was performing no work, or was unloaded, and emitted water by one hole only, it made 115 turns in a minute. This gives a velocity of 46 feet per second for the hole. This is a curious fact: For the water would issue from this hole at rest with the velocity of $37\frac{1}{6}$. This great velocity (which was much less than the velocity with which the water actually quitted the pipe) was undoubtedly produced by the prodigious centrifugal force, which was nearly 17 times the weight of the water in the orifice.

The empty machine weighed 80 pounds, and its weight was half-supported by the upper pressure of the water, so that the friction of the pivots was much diminished. It is a pity that the author has given no account of any work done by the machine. Indeed it was only working ventilators for a large hall. His theory by no means embraces all its principles, nor is it well-founded.

We think that the free motion round the neck of the feeding-pipe without any loss of water or any considerable friction, may be obtained in the following manner: AB (fig. 14.) represents a portion of the revolving horizontal pipe, and CE*ec* part of the feeding pipe. The neck of the first is turned truly cylindrical, so as to turn easily, but without shake, in the collar C*c* of the feeding-pipe, and each has a shoulder which may support the other. That the friction of this joint may not be great, and the pipes destroy each other by wearing, the horizontal pipe has an iron spindle EF, fixed exactly in the axis of the joint, and resting with its pivot F in a step of hard steel, fixed to the iron bar GH, which goes across the feeding-pipe, and is firmly supported in it. This pipe is made bell-shaped, widening below. A collar or hose of thin leather is fitted to the inside of this pipe, and is represented (in section) by LKM*mkl*. This is kept in its place by means of a metal or wooden ring N*n*, thin at the upper edge, and taper-shaped. This is drawn in above the leather, and stretches it, and causes it to apply to the side of the pipe all around. There can be no leakage at this joint, because the water will press the leather to the smooth metal pipe; nor can there be any sensible friction, because the water gets at the edge of the leather, and the whole unbalanced pressure is at the small crevice, between the two metal shoulders. These shoulders need not touch, so that the friction must be insensible. We imagine that this method of tightening a turning joint may be used with great advantage in many cases.

We have only further to observe on this engine, that any imperfection by which the passage of the water is diminished or obstructed produces a saving of water, which is in exact proportion to the diminution of effect. The only inaccuracy that is not thus compensated is when the jets are not at right angles to the arms.

We repeat our wishes, that engineers would endeavour to bring this machine into use, seeing many situations where it may be employed to great advantage. Suppose, for instance, a small supply of water from a great height applied in this manner to a centrifugal pump, or to a hair belt passing over a pulley, and dipping in the water of a deep well. This would be a hydraulic machine exceeding all others in simplicity and durability, though inferior in effect to some other constructions.

2. *Of Undershot Wheels.*

All wheels go by this name where the motion of the water is quicker than that of the partitions or boards of the wheel, and it therefore impels them. These are called the *float boards*, or *floats*, of an undershot wheel. The water, running in a mill-row, with a velocity derived from a head of water, or from a declivity of channel, strikes on these floats, and occasions, by its deflections sidewise and upwards, a pressure on the floats sufficient for impelling the wheel.

There are few points of practical mechanics that have been more considered than the action of water on the floats of a wheel; hardly a book of mechanics being silent on the subject. But the generality of them, at least such as are intelligible to persons who are not very much conversant in dynamical and mathematical discussion, have hardly done any thing more than copied the earliest deductions from the simple theory of the resistance of fluids. The consequence has been, that our practical knowledge is very imperfect; and it is still chiefly from experience that we must learn the performance of undershot wheels. Unfortunately this stops their improvement; because those who have the only opportunities of making the experiments are not sufficiently acquainted with the principles of hydraulics, and are apt to ascribe differences in their performance to trifling nostrums in their construction, or in the manner of applying the impulse of the water.

We have said so much on the imperfection of our theories of the impulse of fluids in the article *Resistance of Fluids*, that we need not repeat here the defects of the common explanations of the motions of undershot wheels. The part of this theory of the impulse of fluids which agrees best with observation is, *that the impulse is in the duplicate proportion of the velocity with which the water strikes the float.* That is, if v be the velocity of the stream, and u the velocity of the float, we shall have F, the impulse on the float when held fast to its impulse f on the float moving with the velocity u, as v^2 to $\overline{v-u}^2$, and $f = F \times \frac{\overline{v-u}^2}{v^2}$.

This is the pressure acting on the float, and urging the wheel round its axis. The wheel must yield to this motion, if the resistance of the work does not exert a superior pressure on the float in the opposite direction. By yielding, the float withdraws from the impulse, and this is therefore diminished. The wheel accelerates, the resistances increase, and the impulses diminish, till they become an exact balance for the resistances. The motion now remains uniform, and the momentum of impulse is equal to that of resistance. The performance of the mill therefore is determined by this; and, whatever be the construction of the mill, its performance is best when the momentum of impulse is greatest. This is had by multiplying the pressure on the float by its velocity. Therefore the momentum will be expressed by $F \times \frac{\overline{v-u}^2}{v^2} \times u$. But since F and v^2 are constant quantities, the momentum will be proportional to $u \times \overline{v-u}^2$. Let x represent the relative velocity. Then $v-x$ will be $=u$, and the momentum will be proportional to $\overline{v-x} \times x^2$, and will be a maximum when $\overline{v-x} \times x^2$ is a maximum, or when $v x^2 - x^3$ is a maximum. This will be discovered by making its fluxion $=o$. That is,

$$2 v x \dot{x} - 3 x^2 \dot{x} = o,$$

and $2 v x - 3 x^2 = o$

or $2 v - 3 x = o$

and $2 v = 3 x$, and $x = \frac{2}{3} v$; and therefore $v-x$, or u, $= \frac{1}{3} v$. That is, the velocity of the float must be one-third of the velocity of the stream. It only remains to say what is the absolute pressure on the float thus circumstanced. Let the velocity v be supposed to arise from the pressure of a head of water h. The common theory teaches that the impulse on a given surface S at rest is equal to the weight of a column h S; put this in place of F, and $\frac{4}{9} v^2$ in place of $\overline{v-u}^2$ and $\frac{1}{3} v$ for u. This gives us $S h \times \frac{4}{27} v$ for the momentum. Now the power expended is $S h v$, or the column $S h$ moving with the velocity v. Therefore the greatest performance of an undershot wheel is equivalent to raising $\frac{4}{27}$ of the water that drives it to the same height.

But this is too small an estimation; for the pressure exerted on a plane surface, situated as the float of a mill-wheel, is considerably greater than the weight of the column S h. This is nearly the pressure on a surface wholly immersed in the fluid. But when a small vein strikes a larger plane, so as to be deflected on all sides in a thin sheet, the impulse is almost double of this. This is in some measure the case in a mill wheel. When the stream strikes it, it is heaped up along its face, and falls back again—and during this motion it is acting with a hydrostatic pressure on it. When the wheel dips into an open river, this accumulation is less remarkable, because much escapes laterally. But in a mill course it may be considerable.

We have considered only the action on one float, but several generally act at once. The impulse on most of them must be oblique, and is therefore less than when the same stream impinges perpendicularly; and this diminution of impulse is, by the common theory, in the proportion of the sine of the obliquity. For this reason it is maintained, that the impulse of the whole stream on the lowest floatboard, which is perpendicular to the stream, is equal to the sum of the impulses made on all the floats which then dip into the water; or that the impulse on any oblique float is precisely equal to the impulse which that part of the stream would have made on the lowest floatboard had it not been interrupted. Therefore it has been recommended to make such a number of floatboards, that when one of them is at the bottom of the wheel, and perpendicular to the stream, the next in succession should be just entering into the water. But since the impulse on a float by no means annihilates all the motion of the water, and it bends round it and hits the one behind with its remaining force, there must be some advantage gained by employing a greater number of floats than this rule will permit. This is abundantly confirmed by the experiments of Smeaton and Bossut. Mr Bossut formed three or four suppositions of the number of floats, and calculated the impulse on each; according to the observations made in a course of experiments made by the Academy of Sciences, and inserted by us in the article *Resistance of Fluids*; and when he summed them up, and compared the results with his experiments, he found the agreement very satisfactory. He deduces a general rule, that if the velocity of the wheel is one-third of that of the stream, and if 72 degrees of the circumference are immersed in the stream, the wheel should have 36 floats. Each will dip one-fifth of the radius. The velocity being still supposed the same, there should be more or fewer floats according as the arch is less or greater than 72 degrees.

Such is the theory, and such are the circumstances which it leaves undetermined. The accumulation of the water on a floatboard, and the force with which it may still strike another, are too intricate to be assigned with any tolerable precision: For such reasons we must acknowledge that the theory of undershot wheels is still very imperfect, and that recourse must be had to experience for their improvement. We therefore strongly recommend the perusal of Mr Smeaton's experiments on undershot wheels, contained in the same dissertation with those we have quoted on overshot wheels. We have only to observe, that to an ordinary reader the experiments will appear too much in favour of undershot wheels. His aim is partly to establish a theory, which will state the relation between their performance and the velocity of of the stream, and partly to state the relation between the power expended and the work done. The velocity in his experiments is always considerably below that which a body would acquire by falling from the surface of the head of water; or it is the velocity acquired by a shorter fall. Therefore if we estimate the power expended by the quantity of water multiplied by this diminished fall, we shall make it too small; and the difference in some cases is very great: yet, even with these concessions, it appears that the utmost performance of an undershot wheel does not surpass the raising one-third of the expended water to the place from which it came. It is therefore far inferior to an overshot wheel expending the same power; and Mr Belidor has led engineers into very mistaken maxims of construction, by saying that overshot wheels should be given up, even in the case of great falls, and that we should always bring on the water from a sluice in the very bottom of the dam, and bring it to the wheel with as great a velocity as possible. Mr Smeaton also says, that the maximum takes place when the velocity of the wheel is two-fifths of that of the stream, instead of two-sixths according to the theory; and this agrees with the experiments of Bossut. But he measured the velocity by means of the quantity of water which run past. This must give a velocity somewhat too small; as will appear by attending to Buat's observations on the superficial, the mean, and the bottom velocities.

The rest of his observations are most judicious, and well adapted to the instruction of practitioners. We have only to add to them the observations of Des Parcieux and Bossut, who have evinced, by very good experiments, that there is a very sensible advantage gained by inclining the floatboards to the radius of the wheel about 20 degrees, so that the lowest floatboard shall not be perpendicular, but have its point turned up the stream about 20 degrees. This inclination causes the water to heap up along the floatboard, and act by its weight. The floats should therefore be made much broader than the vein of water interrupted by them is deep.

Some engineers, observing the great superiority of overshot wheels above undershot wheels driven by the same expence of power, have proposed to bring the water home to the bottom of the wheel on an even bottom, and to make the floatboard no deeper than the aperture of the sluice, which would permit the water to run out. The wheel is to be fitted with a close sole and sides, exactly fitted to the end of this trough, so that if the wheel is at rest, the water may be dammed up by the sole and floatboard. It will therefore press forward the floatboard with the whole force of the head of water. But this cannot answer; for if we suppose no floatboards, the water will flow out at the bottom, propelled in the manner those persons suppose; and it will be supplied from behind, the water coming *slowly* from all parts of the trough to the hole below the wheel. But now add the floats, and suppose the wheel in motion with the velocity that is expected. The other floats must drag into motion all the water which lies between them, giving to the greatest part of it a motion vastly greater than it would have taken in consequence of the pressure of the water behind it; and the water out of the reach of the floats will remain still, which it would not have done independent of the floatboards above it, because it would have contributed to the expence of the hole. The motion therefore which the wheel will acquire by this construction must be so different from what is expected, that we can hardly say what it will be.

We are therefore persuaded that the best way of delivering the water on an undershot wheel in a close mill-course is, to let it slide down a very smooth channel, without touching the wheel till near the bottom, where the wheel should be exactly fitted to the course; or, to make the floats exceedingly broader than the depth of the vein of water which glides down the course, and allow it to be partly intercepted by the first floats, and heap up along them, acting by its weight, after its impulse has been expended. If the bottom of the course be an arch of a circle described with a radius much greater than that of the wheel, the water which slides down will be thus gradually intercepted by the floats.

Attempts have been made to construct water-wheels which receive the impulse obliquely, like the sails of a common wind-mill. This would, in many situations, be a very great acquisition. A very slow but deep river could in this manner be made to drive our mills; and although much power is lost by the obliquity of the impulse, the remainder may be very great. It is to be regretted, that these attempts have not been more zealously prosecuted; for we have no doubt of their success in a very serviceable degree. Engineers have been deterred, because when such wheels are plunged in an open stream, their lateral motion is too much impeded by the motion of the stream. We have seen one, however, which was very powerful: It was a long cylindrical frame, having a plate standing out from it about a foot broad, and surrounding it with a very oblique spiral like a cork-screw. This was plunged about one-fourth of its diameter (which was about 12 feet), having its axis in the direction of the stream. By the work which it was performing, it seemed more powerful than a common wheel which occupied the same *breadth* of the river. Its length was not less than 20 feet: it might have been twice as much, which would have doubled its power, without occupying more of the water-way. Perhaps such a spiral, continued to the very axis, and moving in a hollow canal wholly filled by the stream, might be a very advantageous way of employing a deep and slow stream.

But mills with oblique floats are most useful for employing small streams, which can be delivered from a spout with a great velocity. Mr Bossut has considered these with due attention, and ascertained the best modes of construction. There are two which have nearly equal performances: 1. The vanes being placed like those of a wind-mill, round the rim of a horizontal or vertical wheel, and being made much broader than the vein of water which is to strike them, let the spout be so directed that the vein may strike them perpendicularly. By this measure it will be spread about on the vane in a thin sheet, and exert a pressure nearly equal to twice the weight of a column whose base is the orifice of the spout, and whose height is the fall producing the velocity.

Mills of this kind are much in use in the south of Europe. The wheel is horizontal, and the vertical axis carries the millstone; so that the mill is of the utmost simplicity: and this is its chief recommendation; for its power is greatly inferior to that of a wheel constructed in the usual manner.

2. The vanes may be arranged round the rim of the wheel.

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wheel, not like the sails of a wind-mill, but in planes inclined to the radii, but parallel to the axis, or to the planes passing through the axis. They may either stand on a sole, like the oblique floats recommended by De Parcieux, as above mentioned: or they may stand on the side of the rim, not pointing to the axis, but aside from it.

This disposition will admit the spout to be more conveniently disposed either for a horizontal or a vertical wheel.

We shall conclude this article by describing a contrivance of Mr Burns, the inventor of the double bucketed wheel, for fixing the arms of a water-wheel. It is well known to mill-wrights that the method of fixing them by making them to pass through the axle, weakens it exceedingly, and by lodging water in the joint, soon causes it to rot and fail. They have, therefore, of late years put cast-iron flanches on the axis, to which each arm is bolted: or the flanches are so fashioned as to form boxes, serving as mortises to receive the ends of the arms. These answer the purpose completely, but are very expensive; and it is found that arms of fir bolted into flanches of iron, are apt to work loose. Mr Burns has made wooden flanches of a very curious construction, which are equally firm, and cost much less than the iron ones.

Fig. 15. This flanch consists of eight pieces, four of which compose the ring represented in fig. 15. meeting in the joints *a b*, *a b*, *a b*, *a b*, directed to the centre O. The other four are covered by these, and their joints are represented by the dotted lines $\alpha\,\beta$, $\alpha\,\beta$, $\alpha\,\beta$, $\alpha\,\beta$. These two rings break joint in such a manner that an arm MN is contained between the two nearest joints $a'\,b'$ of the one, and $\alpha'\,\beta'$ of the other. The tenon formed on the one end of the arm A, &c. is of a particular shape: one side, GF, is directed to the centre O; the other side, BCDE, has a small shoulder BC; then a long side CD directed to the centre O; and then a third part DE parallel to GF, or rather diverging a little from it, so as to make up at E the thickness of the shoulder BC; that is, a line from B to E would be parallel to CD. This side of the tenon fits exactly to the corresponding side of the mortise; but the mortise is wider on the other side, leaving a space GFK *h* a little narrower at FK than at G *h*. These tenons and mortises are made extremely true to the square; the pieces are put round the axle, with a few blocks or wedges of soft wood put between them and the axle, leaving the space empty opposite to the place of each arm, and firmly bolted together by bolts between the arm-mortises. The arms are then put in, and each is pressed home to the side CDE, and a wedge HF of hard wood is then put into the empty part of the mortise and driven home. When it comes through the flanch and touches the axle, the part which has come through is cut off with a thin chisel, and the wedge is driven better home. The spaces under the ends of the arms are now filled with wedges, which are driven home from opposite sides, till the circle of the arms stands quite perpendicular on the axle, and all is fast. It needs no hoops to keep it together, for the wedging it up round the axle makes the two half rings draw close on the arms, and it cannot start at its own joints till it crushes the arms. Hoops, however, can do no harm, when all is once wedged up, but it would be improper to put them on before this be done.

A very curious hydraulic machine was erected at Zurich by H. Andreas Wirtz, a tinplate worker of that place. The invention shows him to be a person of very uncommon mechanical knowledge and sagacity. As it is a machine which operates on a principle widely different from all other hydraulic machines, and is really excellent in its kind, we presume that our readers will not be displeased with some account of it.

Fig. 16. is a sketch of the section of the machine, as it was first erected by Wirtz at a dyehouse in Limmat, in the suburbs or vicinity of Zurich. It consists of a hollow cylinder, like a very large grindstone, turning on a horizontal axis, and partly plunged in a cistern of water. The axis is hollow at one end, and communicates with a perpendicular pipe CBZ′, part of which is hid by the cylinder. This cylinder or drum is formed into a spiral canal by a plate coiled up within it like the main-spring of a watch in its box; only the spires are at a distance from each other, so as to form a conduit for the water of uniform width. This spiral partition is well joined to the two ends of a cylinder, and no water escapes between them. The outermost turn of the spiral begins to widen about three-fourths of a circumference from the end, and this gradual enlargement continues from Q to S nearly a semicircle: this part may be called the Horn. It then widens suddenly, forming a Scoop or shovel SS′. The cylinder is supported so as to dip several inches into the water, whose surface is represented by VV′.

When this cylinder is turned round its axis in the direction ABEO, as expressed by the two darts, the scoop SS′ dips at V′, and takes up a certain quantity of water before it emerges again at V. This quantity is sufficient to fill the taper part SQ, which we have called the Horn; and this is nearly equal in capacity to the outermost uniform spiral round.

After the scoop has emerged, the water passes along the spiral by the motion of it round the axis, and drives the air before it into the rising-pipe, where it escapes.—In the mean time, air comes in at the mouth of the scoop; and when the scoop again dips into the water, it again takes in some. Thus there is now a part filled with water and a part filled with air. Continuing this motion, we shall receive a second round of water and another of air. The water in any turn of the spiral will have its two ends on a level; and the air between the successive columns of water will be in its natural state; for since the passage into the rising-pipe or Main is open, there is nothing to force the water and air into any other position. But since the spires gradually diminish in their length, it is plain that the column of water will gradually occupy more and more of the circumference of each. At last it will occupy a complete turn of some spiral that is near the centre; and when sent farther in, by the continuance of the motion, some of it will run back over the top of the succeeding spiral. Thus it will run over at K 4 into the right-hand side of the third spiral. Therefore it will push the water of this spire backwards, and raise its other end, so that it also will run over backwards *before* the next turn be completed. And this change of disposition will at last reach the first or outermost spiral, and some water will run over into the horn and scoop, and finally into the cistern.

But as soon as water gets into the rising-pipe, and rises

rises a little in it, it stops the escape of the air when the next scoop of water is taken in. Here are now two columns of water acting against each other by hydrostatic pressure and the intervening column of air. They must compress the air between them, and the water and air columns will now be unequal. This will have a general tendency to keep the whole water back, and cause it to be higher on the left or rising side of each spire than on the right descending side. The excess of height will be just such as produces the compression of the air between that and the preceding column of water. This will go on increasing as the water mounts in the rising-pipe; for the air next to the rising-pipe is compressed at its inner end with the weight of the whole column in the main. It must be as much compressed at its outer end. This must be done by the water column without it; and this column exerts this pressure partly by reason that *its* outer end is higher than its inner end, and partly by the transmission of the pressure on its outer end by air, which is similarly compressed from without. And thus it will happen that each column of water, being higher at its outer than at its inner end, compresses the air on the water column beyond or within it, which transmits this pressure to the air beyond it, adding to it the pressure arising from its own want of level at the ends. Therefore the greatest compression, viz. that of the air next the main, is produced by *the sum of all the transmitted pressures;* and these are the sum of all the differences between the elevation of the inner ends of the water columns above their outer ends: and the height to which the water will rise in the main will be just equal to this sum.

Draw the horizontal lines K'K 1, K'K 2, K'K 3, &c. and *m n*, *m n*, *m n*, &c. Suppose the left-hand spaces to be filled with water, and the right-hand spaces to be filled with air. There is a certain gradation of compression which will keep things in this position. The spaces evidently decrease in arithmetical progression; so do the hydrostatic heights and pressures of the water columns. If therefore the air be dense in the same progression, all will be in hydrostatical equilibrium. Now this is evidently producible by the mere motion of the machine; for since the density and compression in each air column is supposed inversely as the bulk of the column, the absolute quantity of air is the same in all; therefore the column first taken in will pass gradually inwards, and the increasing compression will cause it to occupy precisely the whole right-hand side of every spire. The gradual diminution of the water columns will be produced during the motion by the water running over backwards at the top, from spire to spire, and at last coming out by the scoop.

It is evident that this disposition of the air and water will raise the water to the greatest height, because the hydrostatic height of each water column is the greatest possible, viz. the diameter of the spire. This disposition may be obtained in the following manner: Take CL to CB as the density of the external air to its density in the last column next the rising-pipe or main; that is, make CL to CB as 33 feet (the height of the column of water which balances the atmosphere), to the sum of 33 feet and the height of the rising-pipe. Then divide BL into such a number of turns, that the sum of their diameters shall be equal to the height of the main; then bring a pipe straight from E to the centre C. The reason of all this is very evident.

But when the main is very high, this construction will require a very great diameter of the drum, or many turns of a very narrow pipe. In such cases it will be much better to make the spiral in the form of a corkscrew, as in fig. 17. instead of this flat form like a watch-spring. The pipe which forms the spiral may be lapped round the frustum of a cone, whose greatest diameter is to the least (which is next to the rising-pipe) in the same proportion that we assigned to CB and CL. By this construction the water will stand in every round so as to have its upper and lower surfaces tangents to the top and bottom of the spiral, and the water columns will occupy the whole ascending side of the machine, while the air occupies the descending side. Fig. 17.

This form is vastly preferable to the flat: it will allow us to employ many turns of a large pipe, and therefore produce a great elevation of a large quantity of water.

The same thing will be still better done by lapping the pipe on a cylinder, and making it taper to the end, in such a proportion that the contents of each round may be the same as when it is lapped round the cone. It will raise the water to a greater height (but with an increase of the impelling power) by the same number of turns, because the vertical or pressing height of each column is greater.

Nay, the same thing may be done in a more simple manner, by lapping a pipe of uniform bore round a cylinder. But this will require more turns, because the water columns will have less differences between the heights of their two ends. It requires a very minute investigation to show the progress of the columns of air and water in this construction, and the various changes of their arrangement, before one is attained which will continue during the working of the machine.

We have chosen for the description of the machine that construction which made its principle and manner of working most evident, namely, which contained the same material quantity of air in each turn of the spiral, more and more compressed as it approaches to the rising-pipe. We should otherwise have been obliged to investigate in great detail the gradual progress of the water, and the frequent changes of its arrangement, before we could see that one arrangement would be produced which would remain constant during the working of the machine. But this is not the best construction. We see that, in order to raise water to the height of a column of 34 feet, which balances the atmosphere, the air in the last spire is compressed into half its bulk; and the quantity of water delivered into the main at each turn is but half of what was received into the first spire, the rest flowing back from spire to spire, and being discharged at the spout.

But it may be constructed so as that the quantity of water in each spire may be the same that was received into the first; by which means a greater quantity (double in the instance now given) will be delivered into the main, and raised to the same height by very nearly the same force.—This may be done by another proportion of the capacity of the spires, whether by a change of their caliber or of their diameters. Suppose the bore to be the same, the diameter must be made such that the constant column of water, and the column of air, compressed

Water-works. pressed to the proper degree, may occupy the whole circumference. Let A be the column of water which balances the atmosphere, and h the height to which the water is to be raised. Let A be to $A+h$ as 1 to m.

It is plain that m will represent the density of the air in the last spire, if its natural density be 1, because it is pressed by the column $A+h$, while the common air is pressed by A. Let 1 represent the constant water column, and therefore nearly equal to the air column in the first spire. The whole circumference of the last spire must be $1+\frac{1}{m}$, in order to hold the water 1, and the air compressed into the space $\frac{1}{m}$ or $\frac{A}{A+h}$.

The circumference of the first spire is $1+1$ or 2. Let D and d be the diameters of the first and last spires; we have $2:1+\frac{1}{m}=D:d$, or $2m:m+1=D:d$. Therefore if a pipe of uniform bore be lapped round a cone, of which D and d are the end diameters, the spirals will be very nearly such as will answer the purpose. It will not be quite exact, for the intermediate spirals will be somewhat too large. The conoidal frustum should be formed by the revolution of a curve of the logarithmic kind. But the error is very trifling.

With such a spiral, the full quantity of water which was confined in the first spiral will find room in the last, and will be sent into the main at every turn. This is a very great advantage, especially when the water is to be much raised. The saving of power by this change of construction is always in proportion of the greatest compression of the air.

The great difficulty in the construction of any of these forms is in determining the form and position of the horn and the scoop; and on this greatly depends the performance of the machine. The following instructions will make it pretty easy.

Fig. 18. Let ABEO (fig. 18.) represent the first or outermost round of the spiral, of which the axis is C. Suppose it immerged up to the axis in the water VV′, we have seen that the machine is most effective when the surfaces KB and O n of the water columns are distant the whole diameter BO of the spiral. Therefore let the pipe be first supposed of equal caliber to the very mouth E e, which we suppose to be just about to dip into the water. The surface O n is kept there, in opposition to the pressure of the water column BAO, by the compressed air contained in the quadrant OE, and in the quadrant which lies behind EB. And this compression is supported by the columns behind, between this spire and the rising pipe. But the air in the outermost quadrant EB is in its natural state, communicating as yet with the external air. When, however, the mouth E e has come round to A, it will not have the water standing in it in the same manner, leaving the half space BEO filled with compressed air; for it took in and confined only what filled the quadrant BE. It is plain, therefore, that the quadrant BE must be so shaped as to take in and confine a much greater quantity of air; so that when it has come to A, the space BEO may contain air sufficiently dense to support the column AO. But this is not enough: For when the wide mouth, now at A a, rises up to the top, the surface of the water in it rises also, because the part AO o a is more capacious than the cylindric part OE e o which succeeds it, and which cannot contain all the water that it does. Since, then, the water in the spire rises above A, it will press the water back from O n to some other position m' n', and the pressing height of the water column will be diminished by this rising on the other side of O. In short, the horn must begin to widen, not from B, but from A, and must occupy the whole semicircle ABE; and its capacity must be to the capacity of the opposite cylindrical side as the sum of BO, and the height of a column of water which balances the atmosphere to the height of that column. For then the air which filled it, when of the common density, will fill the uniform side BEO, when compressed so as to balance the vertical column BO. But even this is not enough; for it has not taken in enough of water. When it dipped into the cistern at E, it carried air down with it, and the pressure of the water in the cistern caused the water to rise into it a little way; and some water must have come over at B from the other side, which was drawing narrower. Therefore when the horn is in the position EOA, it is not full of water. Therefore when it comes into the situation OAB, it cannot be full nor balance the air on the opposite side. Some will therefore come out at O, and rise up through the water. The horn must therefore, 1st, Extend at least from O to B, or occupy half the circumference; and, 2dly, It must contain at least twice as much water as would fill the side BEO. It will do little harm though it be much larger; because the surplus of air which it takes in at E will be discharged, as the end E e of the horn rises from O to B, and it will leave the precise quantity that is wanted. The overplus water will be discharged as the horn comes round to dip again into the cistern. It is possible, but requires a discussion too intricate for this place, to make it of such a size and shape, that while the mouth moves from E to B, passing through O and A, the surface of the water in it shall advance from E e to O n, and be exactly at O when the beginning or narrow end of the horn arrives there.

We must also secure the proper quantity of water. When the machine is so much immersed as to be up to the axis in water, the capacity which thus secures the proper quantity of air will also take in the proper quantity of water. But it may be erected so as that the spirals shall not even reach the water. In this case it will answer our purpose if we join to the end of the horn a scoop or shovel QRSB (fig. 19.), which is so formed as to take in at least as much water as will fill the horn. Fig. 19. This is all that is wanted in the beginning of the motion along the spiral, and more than is necessary when the water has advanced to the succeeding spire; but the overplus is discharged in the way we have mentioned. At the same time, it is needless to load the machine with more water than is necessary, merely to throw it out again. We think that if the horn occupies fully more than one half of the circumference, and contains as much as will fill the whole round, and if the scoop lifts as much as will certainly fill the horn, it will do very well.

N. B. The scoop must be very open on the side next the axis, that it may not confine the air as soon as it enters the water. This would hinder it from receiving water enough.

The

Fig. 1.

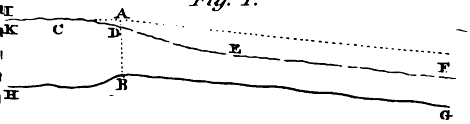


Fig. 2.

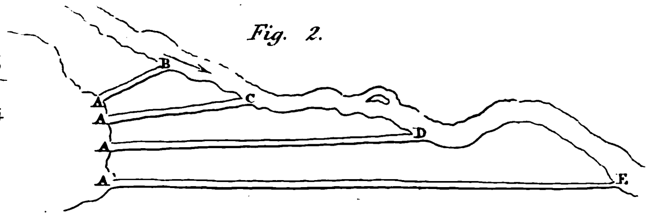


Fig. 3.

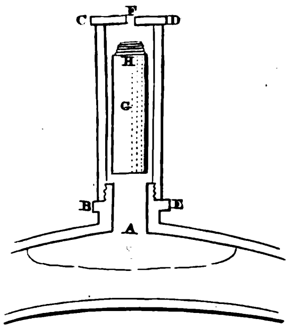


Fig. 4.

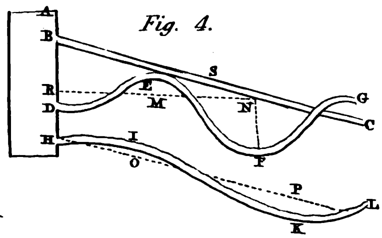


Fig. 5.

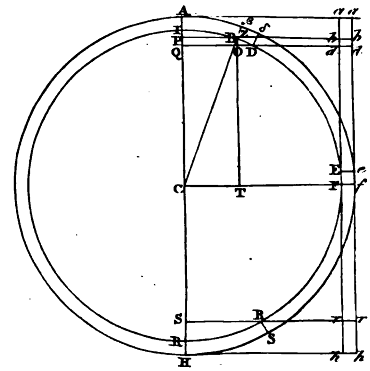


Fig. 6.

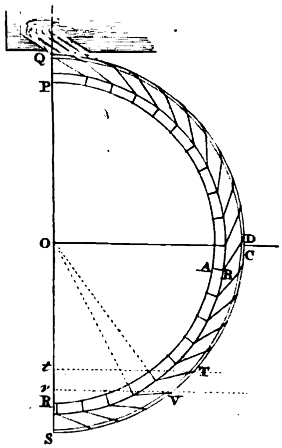


Fig. 7.

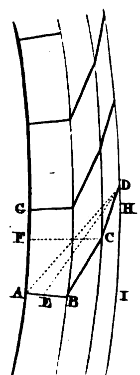


Fig. 8.

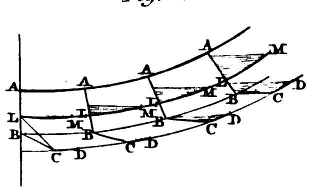


Fig. 9.

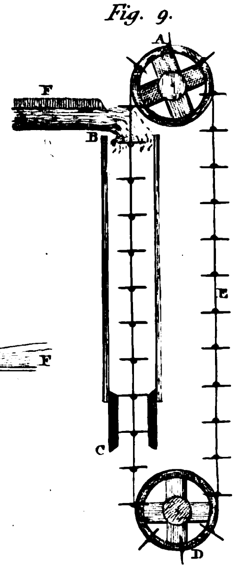


Fig. 10.

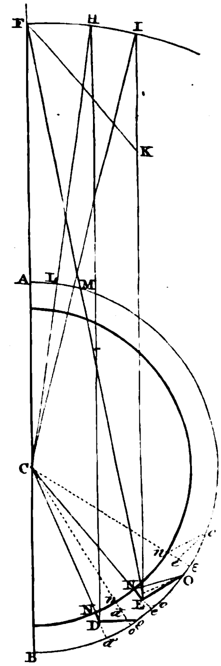
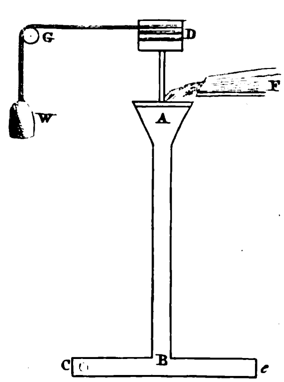


Fig 11.



W. Train Sculpt.

Water Works

Fig. 12

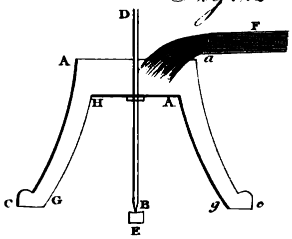


Fig. 13

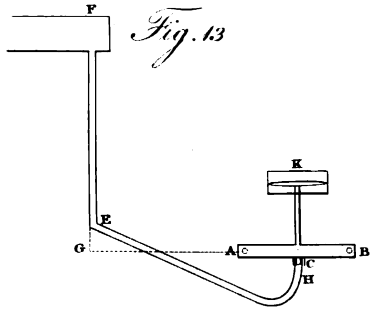


Fig. 14

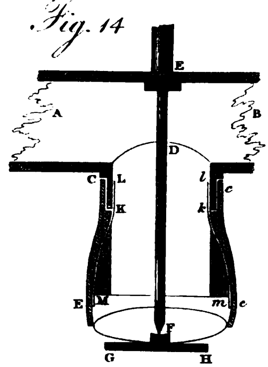


Fig. 15

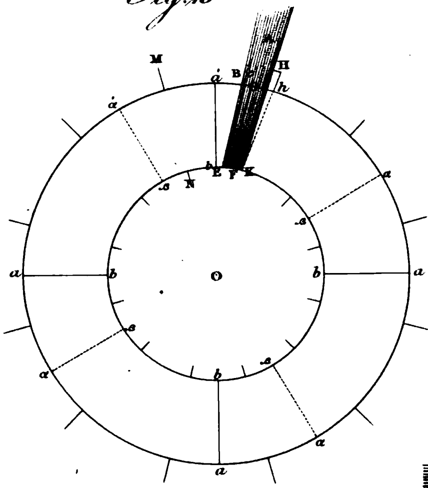


Fig. 16

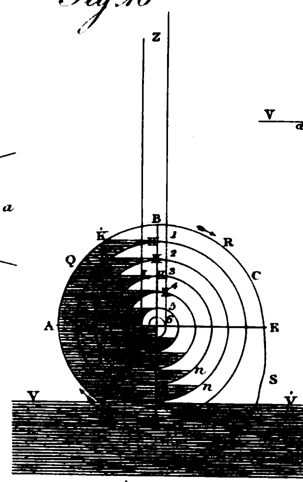


Fig. 18

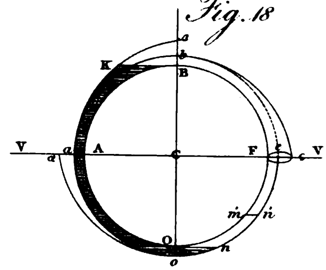


Fig. 20

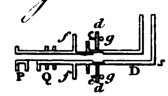


Fig. 17

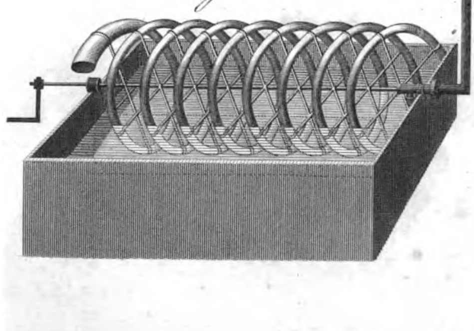
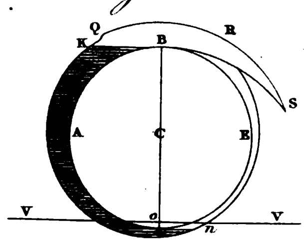


Fig. 19



Smith Sc. Clements Inn. Strand.

Water-works.

The following dimensions of a machine erected at Florence, and whose performance corresponded extremely well with the theory, may serve as an example.

The spiral is formed on a cylinder of 10 feet diameter, and the diameter of the pipe is 6 inches. The smaller end of the horn is of the same diameter; and it occupies three-fourths of the circumference, and it is $7\frac{8}{10}$ths inches wide at the outer end. Here it joins the scoop, which lifts as much water as fills the horn, which contains 4340 Swedish cubic inches, each $=1.577$ English. The machine makes six turns in a minute, and raises 1354 pounds of water, or 22 cubic feet, 10 feet high in a minute.

The above account will, we hope, sufficiently explain the manner in which this singular hydraulic machine produces its effect. When every thing is executed by the maxims which we have deduced from its principles, we are confident that its performance will correspond to the theory; and we have the Florentine machine as a proof of this. It raises more than $\frac{10}{11}$ths of what the theory promises, and it is not perfect. The spiral is of equal caliber, and is formed on a cylinder. The friction is so inconsiderable in this machine, that it need not be mended: but the great excellency is that whatever imperfection there may be in the arrangement of the air and water columns, this only affects the elegance of the execution, causing the water to make a few more turns in the spiral before it can mount to the height required; but wastes no power, because the power employed is always in proportion to the sum of the vertical columns of water in the rising side of the machine; and the height to which the water is raised by it is in the very same proportion. It should be made to move very slow, that the water be not always dragged up by the pipes, which would cause more to run over from each column, and diminish the pressure of the remainder.

If the rising-pipe be made wide, and thus room be made for the air to escape freely up through the water, it will rise to the height assigned; but if it be narrow, so that the air cannot get up, it rises almost as slow as the water, and by this circumstance the water is raised to a much greater height mixed with air, and this with hardly any more power. It is in this way that we can account for the great performance of the Florentine machine, which is almost triple of what a man can do with the finest pump that ever was made: indeed the performance is so great, that one is apt to suspect some inaccuracy in the accounts. The entry into the rising-pipe should be no wider than the last part of the spiral; and it would be advisable to divide it into four channels by a thin partition, and then to make the rising-pipe very wide, and to put into it a number of slender rods, which would divide it into slender channels that would completely entangle the air among the water. This will greatly increase the height of the heterogeneous column. It is surprising that a machine that is so very promising should have attracted so little notice. We do not know of any being erected out of Switzerland except at Florence in 1778. The account of its performance was in consequence of a very public trial in 1779, and honourable declaration of its merit, by Sig. Lorenzo Ginori, who erected another, which fully equalled it. It is shortly mentioned by Professor Sulzer of Berlin, in the *Sammlungen Vermischten Schriften* for 1754. A description of it is published by the Philosophical Society of Zurich in 1766, and in the descriptions published by the Society in London for the encouragement of arts in 1766. The celebrated Daniel Bernoulli has published a very accurate theory of it in the Petersburgh Commentaries for 1772, and the machines at Florence were erected according to his instructions. Baron Alstromer in Sweden caused a glass model of it to be made, to exhibit the internal motions for the instruction of artists, and also ordered an operative engine to be erected; but we have not seen any account of its performance. It is a very intricate machine in its principles; and an ignorant engineer, nay the most intelligent, may erect one which shall hardly do any thing; and yet, by a very trifling change, may become very powerful. We presume that failures of this kind have turned the attention of engineers from it; but we are persuaded that it may be made very effective, and we are certain that it must be very durable. Fig. 20. is a section of the manner in which the author has formed the communication between the spiral and the rising pipe. P is the end of the hollow axis which is united with the solid iron axis. Adjoining to P, on the under side, is the entry from the last turn of the spiral. At Q is the collar which rests on the supports, and turns round in a hole of bell-metal. *ff* is a broad flanch cast in one piece with the hollow part. Beyond this the pipe is turned somewhat smaller, very round and smooth, so as to fit into the mouth of the rising pipe, like the key of a cock. This mouth has a plate *ee* attached to it. There is another plate *dd*, which is broader than *ee*, and is not fixed to the cylindrical part, but moves easily round it. In this plate are four screws, such as *g*, *g*, which go into holes in the plate *ff*, and thus draw the two plates *ff* and *dd* together, with the plate *ee* between them. Pieces of thin leather are put on each side of *ee*; and thus all escape of water is effectually prevented, with a very moderate compression and friction. Fig. 20.

Waterford.

WATERFORD, a city and sea-port of Ireland, in a county of the same name, with a bishop's see. It is the second place in the kingdom, and is a wealthy, populous city, enjoying many ample privileges. The streets are narrow, and the air is not very healthy; but it has an excellent harbour, seated as well for trade as any in the world, and ships of the greatest burden may ride at the quay. It stands on the river Sure, 8 miles north of St George's Channel, 26 south of Kilkenny, and 75 south-by-west of Dublin. W. Long. 7. 8. N. Lat. 52. 14.

WATERFORD, a county of Ireland, 46 miles in length, and 25 in breadth; bounded on the south by St George's Channel; on the west by Cork; on the north by the river Sure, which separates it from Tipperary and Kilkenny; and on the east by Waterford haven, which parts it from Wexford. It contains 71 parishes, and sends two members to parliament. It is a fine country, very pleasant and rich, and the principal place is of the same name. See WATERFORD, SUPPLEMENT.

Waterford, Watering.

WATERING, in the manufactures, is to give a lustre

lustre to stuffs, &c. by wetting them lightly with gum-water, and then passing them through the press or calender whether hot or cold.

WATERLAND, Dr Daniel, a learned English divine who distinguished himself greatly in theological controversies, was born in 1683 at Wasely in Lincolnshire, of which place his father was rector. He had his academical learning at Magdalen college, Cambridge, where he drew up a useful tract, which went through several editions, intitled, *Advice to a Young Student, with a Method of Study for the first four years*. In 1713 he became master of the college, was soon after appointed chaplain to George I.; and at the time of his death in 1740, was canon of Windsor, archdeacon of Middlesex, and vicar of Twickenham, Besides his controversial writings, he published two volumes of sermons.

WATSON, Dr Robert, an elegant historian, was born at St Andrew's in Scotland, about the year 1730. He was the son of an apothecary of that place, who was also a brewer. Having gone through the usual course of languages and philosophy at the school and university of his native place, and also entered on the study of divinity, a desire of being acquainted with a larger circle of literati, and of improving himself in every branch of knowledge, carried him, first to the university of Glasgow, and afterwards to that of Edinburgh. The period of theological studies at the universities of Scotland is four years: but during that period, young men of ingenious minds find sufficient leisure to carry on and advance the pursuits of general knowledge. Mr Watson pursued his studies with ardour. Few men ever studied more constantly. It was a rule with him to study eight hours every day; and this law he observed during the whole course of his life. An acquaintance with the polite writers of England, after the union of the two kingdoms, became general in Scotland; and in Watson's younger years, an emulation began to prevail of writing pure and elegant English. Mr Watson applied himself with great industry to the principles of philosophical or universal grammar; and by a combination of these, with the authority of the best English writers, formed a course of lectures on style or language. He proceeded to the study of rhetoric or eloquence; the principles of which he endeavoured to trace to the nature of the human mind. He delivered a course of lectures in Edinburgh on these subjects; and met with the countenance, approbation, and friendship of Lord Kames, Mr Hume, with other men of genius and learning.

At this time he had become a preacher; and a vacancy having happened in one of the churches of St Andrew's, he offered himself a candidate for that living, but was disappointed. Soon after he was appointed professor of logic; and he obtained also a patent from the crown, constituting him professor of rhetoric and belles lettres. The study of logic in St Andrew's, as in most other places, was at this time confined to syllogisms, modes, and figures. Mr Watson, whose mind had been opened by conversation, and by reading the writings of the wits that had begun to flourish in the Scotch capital, prepared and read to his students a course of metaphysics and logics on the most enlightened plan; in which he analyzed the powers of the mind, and entered deeply into the nature of the different species of evidence of truth or knowledge. By his history of Philip II. Dr Watson attained in his lifetime a considerable degree of celebrity; and his history of Philip III. published after his death, has added to his fame. Of this last performance, however, he has only completed the first four books; the two last were written by the editor of his manuscript, at the desire of the guardians of his children.

On the death of Principal Tulideph, Dr Watson, was appointed his successor; in which station he lived only a few years. He married a lady of singular beauty and virtue, daughter to Mr Shaw, professor of divinity in St Mary's college, St Andrew's. By this lady he had five daughters, who survived him.

WATT, James, the celebrated improver of the steam engine, see Supplement.

WATTS, Dr Isaac, a learned and eminent dissenting minister, was born at Southampton in 1674, of parents eminent for piety, and considerable sufferers for conscience-sake. In 1690 he was sent up to London for academical education under the tuition of the Rev. Mr Thomas Rowe; and in 1696 was himself engaged as tutor to the son of Sir John Hartopp, Bart. at Stoke Newington. He began to preach in 1698, and met with general acceptance; and after officiating as an assistant to the Rev. Dr Isaac Chauncy, he succeeded in his pastoral charge in 1702, and continued to preside over that church as long as he lived. Though his whole income did not amount to an hundred a-year, he allotted one third of it to the poor. He died in 1748. His numerous works have rendered his name famous among people of every denomination, both in this and other countries, and have been translated into a variety of languages. His Lyric Poems, his Psalms and Hymns, and his Divine Songs for Children, have had an amazing number of editions. His logic and philosophy have been much admired. He also wrote works upon a variety of other subjects, and printed several volumes of his sermons. He was admired for the mildness and benevolence of his disposition. After his death, his works were collected, and published in six volumes quarto.

WAVE, in *Philosophy*, a cavity in the surface of water, or other fluids, with an elevation aside thereof.

The waves of the sea are of two kinds, natural and accidental. The natural waves are those which are exactly proportioned in size to the strength of the wind, whose blowing gives origin to them. The accidental waves are those occasioned by the wind's reacting upon itself by repercussion from hills and mountains, or high shores, and by the washing of the waves themselves, otherwise of the natural kind, against rocks and shoals: all these causes give the waves an elevation, which they can never have in their natural state. For the height of the waves, see Sea.

Stilling Waves by means of Oil. See Sea.

WAVED, in *Heraldry*, is said of a bordure, or any ordinary or charge, in a coat of arms, having its outlines indented in manner of the rising and falling of waves: it is used to denote, that the first of the family in whose arms it stands, acquired its honours by sea-service.

WAVING, in the sea-language, is the making signs to a vessel to come near or keep off.

WAX, or *Bees Wax*, in *Natural History*, a firm and solid substance, moderately heavy, and of a fine yellow colour, formed by the bees from the pollen of flowers. See Apis.

The

Wax.

The best sort is that of a lively yellow colour, and an agreeable smell, somewhat like that of honey: when new, it is toughish, yet easy to break; but by age it becomes harder and more brittle, loses its fine colour, and in a great measure its smell.

It appears that wax and the pollen have for their basis a fat oil, which passes to the state of resin by its combination with oxygen. If the nitric or muriatic acid be digested upon fixed oil for several months, it passes to a state resembling wax. Wax, by repeated distillations, affords an oil which possesses all the properties of volatile oils. It is reduced into water and carbonic acid by combustion. The colouring matter of wax is insoluble in water and in alcohol.

Fixed alkalies dissolve wax, and render it soluble in water. It is this saponaceous solution which forms the punic wax. It may be used as the basis of several colours; and may be made into an excellent paste for washing the hands. Ammoniac likewise dissolves it; and as this solvent is evaporable, it ought to be preferred when it is proposed to use the wax as a varnish.

From the common yellow wax, by bleaching, is formed white-wax, sometimes called, very improperly, *virgin-wax*. The greater the surface is in proportion to the quantity, the sooner and more perfectly this operation is performed. The usual way is to melt the wax in hot water; when melted, they press it through a strainer of tolerable fine linen, and pour it into round and very shallow moulds. When hardened by cooling, it is taken out and exposed to the sun and air, sprinkling it now and then with water, and often turning it: by this means it soon becomes white. The best sort is of a clear and almost transparent whiteness, dry, hard, brittle, and of an agreeable smell, like that of the yellow wax, but much weaker.

The common yellow wax is of very great use both in medicine and in many of the arts and manufactures. It has been sometimes given internally in dysenteries and erosions of the intestines; but its great use is in the making ointments and plasters, and the greater part of those of the shops owe their consistence to it. The white wax is also an ingredient in some of the cerates and ointments of the shops; and it is used in making candles, and in many of the nicer arts and manufactures where wax is required.

Sealing-Wax, or *Spanish-Wax*, is a composition of gum lac, melted and prepared with resins, and coloured with some suitable pigment.

There are two kinds of sealing-wax in use; the one hard, intended for sealing letters, and other such purposes; the other soft, designed for receiving the impressions of seals of office to charters, patents, and such written instruments. The best hard red sealing-wax is made by mixing two parts of shell lac, well powdered, and resin and vermilion, powdered, of each one part, and melting this combined powder over a gentle fire; and when the ingredients seem thoroughly incorporated, working the wax into sticks. Seed-lac may be substituted for the shell-lac; and instead of resin, boiled Venice turpentine may be used. A coarser hard red sealing-wax may be made, by mixing two parts of resin, and of shell-lac, or vermilion and red lead, mixed in the proportion of one part of the vermilion to two of the red lead, of each one part; and proceeding as in the former preparation. For a cheaper kind, the vermilion may be omitted, and the shell-lac also, for very coarse uses. Wax of other colours is made by substituting other colouring matters for vermilion, as verditer for blue, ivory black for black wax. For uncoloured soft sealing-wax, take of bees wax, one pound; of turpentine, three ounces; and of olive oil, one ounce; place them in a proper vessel over the fire, and let them boil for some time; and the wax will be then fit to be formed into rolls or cakes for use. For red, black, green, blue, yellow, and purple soft sealing-wax, add to the preceding composition an ounce or more of any ingredients directed above for colouring the hard sealing-wax, and stir the mass till the colouring ingredients be incorporated with the wax.

Wax, Way.

Wax-Work, the representation of the faces, &c. of persons living or dead; made by applying plaster of Paris in a kind of paste, and thus forming a mould containing the exact representation of the features. Into this mould melted wax is poured, and thus a kind of masks are formed; which being painted and set with glass eyes, and the figures dressed in their proper habits, they bear such a resemblance that it is difficult to distinguish between the copy and the original.

WAY, a passage or road.

The Roman ways are divided into consular, prætorian, military, and public; and of these we have four remarkable ones in England: the first, Watling-street, or Watheling-street, leading from Dover to London, Dunstable, Toucester, Atterston, and the Severn, extending as far as Anglesea in Wales. The second, called *Hikenild* or *Ikenild street*, stretches from Southampton over the river Isis at Newbridge; thence by Camden and Litchfield; then passes the Derwent near Derby, and ends at Tinmouth. The third, called *Fosse-way*, because in some places it was never perfected, but lies as a large ditch, leads from Cornwall through Devonshire, by Tethbury, near Stow in the Wolds; and beside Coventry to Leicester, Newark, and so to Lincoln. The fourth, called *Erming* or *Erminage street*, extends from St David's, in Wales, to Southampton.

Way Covert, *Gang*, *Hatch*. See Covert *Way*, *Gang*, &c.

Way of a Ship, is sometimes the same as her rake, or run forward or backward: but this term is most commonly understood of her sailing.

Way-Leaves, in the coal business. See Coalery, N° 3.

Right of Ways, in *Law*. This may be grounded on a special permission; as when the owner of the land grants to another a liberty of passing over his grounds, to go to church, to market, or the like: in which case the gift or grant is particular, and confined to the grantee alone; it dies with the person; and if the grantee leaves the country, he cannot assign over his right to any other; nor can he justify taking another person in his company. A way may be also by prescription; as if all the owners and occupiers of such a farm have immemorially used to cross another's ground; for this immemorial usage supposes an original grant, whereby a right of way thus appurtenant to land may clearly be created. A right of way may also arise by act and operation of law; for if a man grants me a piece of ground in the middle of his field, he at the same time tacitly and impliedly gives me a way to come at it; and I may cross his land for that purpose without trespass. For when the law doth give any thing to one, it giveth impliedly whatsoever is necessary for enjoying the same. By the law of the twelve tables at Rome, where a man had a right of way over another's land, and the road was out of repair, he who had the right of way might go over any part of the land he pleased; which was the established rule in public as well as private ways. And the law of England, in both cases, seems to correspond with the Roman.

WAYFARING TREE. See VIBURNUM, BOTANY *Index*.

WAYGHTES, or WAITS, a word which is used only in the plural number, and signifies *hautboys*. It is now applied to the performers on these and other musical instruments, by a transition from the instruments themselves, and particularly to those performers who parade the streets by night, about the Christmas season of the year.

WAYWODE, is a title formerly given to the governors of the chief places in the dominions of the czar of Muscovy. The palatines, or governors of provinces in Poland, also bear the quality of *waywodes* or *waiwodes*. The Poles likewise call the princes of Wallachia and Moldavia *waywodes*; as esteeming them no other than on the foot of governors; pretending that Wallachia and Moldavia are provinces of Poland. Everywhere else these are called *hospodars*. Du Cange says, that the name *waywode* is used in Dalmatia, Croatia, and Hungary, for a general of an army; and Leunclavius, in his Pandects of Turkey, tells us, it usually signifies *captain* or *commander*.

WEANING, putting a child away from the breast, and bringing it to use common food.

WEAR, or WEER, a great stank or dam in a river, fitted for the taking of fish, or for conveying the stream to a mill. New wears are not to be made, or others altered, to the nuisance of the public, under a certain penalty. See RIVER.

WEARING, or VEERING, in *Seamanship*. See SEAMANSHIP.

WEASEL. See MUSTELA, MAMMALIA *Index*.

WEATHER denotes the state of the atmosphere with regard to heat and cold, wind, rain, and other meteors. See METEOROLOGY.

WEATHER, in sea-language, is used as an adjective, and applied by mariners to every thing lying to windward of a particular situation: thus, a ship is said to have the weather-gage of another, when she is farther to windward. Thus also, when a ship under sail presents either of her sides to the wind, it is then called the *weather-side* or *weather board*; and all the rigging and furniture situated thereon are distinguished by the same epithet, as the *weather-shrouds*, the *weather-lifts*, the *weather-braces*, &c.

To WEATHER, in sea-language, is to sail to windward of some ship, bank, or head-land.

WEATHER-*Cock*, a moveable vane, in form of a cock, or other shape, placed on high, to be turned round according to the direction of the wind, and point out the quarter from whence it blows.

WEATHER *Glass*. See BAROMETER.

WEATHERING, among sailors, signifies the doubling or sailing by a head-land or other place.

WEAVING, the art of working a web of cloth, silk, or other stuff, in a loom with a shuttle. For an idea of the manner in which this is performed, see CLOTH.

WEAVING-*Loom*, a machine for weaving cloth, silk, &c. by raising the threads of the warp in order to throw in the shoot, and strike it close. Of these there are various kinds, distinguished by the different sorts of cloths, stuffs, silks, &c. in which they are employed, and which are chiefly distinguished by the number and variety of the threads they raise in order to work the warp, either plain or in figures, by making more or less of the woof or shoot appear through the warp. In order to give a general idea of weaving, we shall here describe the parts of the common weaver's loom. Fig. 1. in which *e f*, *e f* are the front posts, and *g*, *g* the back posts of the loom; *l l l*, *m m*, *m m* are the *lams* in their place at Q, or, as they are called in some parts of Scotland, the *headles*, and in others the *sleves*. They are composed of strong threads, stretched between two horizontal bars, an upper and a lower. The threads of one lam are so disposed as to pass between the upper threads of the warp, while they admit the lower threads to pass through loops or small holes in them, and the disposition of the threads of the other lam is such, that while they pass between the lower threads of the warp, they admit the upper threads to pass through the small holes just mentioned. The lams are suspended from the cross bar or *lam-bearer* HH, by means of ropes *n*, *n* passing from the upper bars of the *lams* over the pulleys at EE, and balanced by weights at the other ends. From the lower bar of each *lam* or *headle* a rope passes to the *treadles* or moveable bar at OO; so that when a foot presses a treadle, the lam fastened to it sinks, while the other rises by means of the balancing weight suspended from the pulley at E. The workman then throws in the woof by means of the shuttle, and closes it by one or two strokes of the *lay* or *batten*, of which WB, WB are called the *swords*, CC the *cap*, or in Scotland the upper *shell*, DD the *block* or under *shell*, and PP the *reed* or comb contained between these shells. LL is the bench on which the workmen sit; for the loom which our figure represents is constructed for weaving cloth of such a breadth as to require two workmen, who have their quills in a box *d* on the middle of the bench on which they sit. Between the workmen's bench and the *batten* or *lay* is the *breast-bar* I, I, a smooth square beam, in which there is an opening to let the web through as it is wove. From this opening the web SS passes to the *knee roll* or *web beam* GG, round which it is rolled by means of the spokes, visible in the figure, and kept from being unrolled by a wheel with teeth and clench, visible likewise in the figure. In some looms the web passes from the knee roll to the wooden frame X, to be dried as it is wove. Opposite to the breast-bar, and on the other side of the *batten* or *lay*, is the *cane-roll* or *yarn-beam*, on which the warp is rolled when put into the loom, and from which it is gradually unrolled as the work proceeds. TT are bobbins filled with yarn of the warp to mend such threads of it as may be broke in the weaving; and B *b*, B *b* are clues of the same kind of yarn with the borders of the warp, to mend such threads as may there be broken.

Plate DLIII. fig. 1.

Fig. 2. represents the common shuttle with the vacuity in the middle, in which the quill with the woof is placed on a spindle or axis. As this shuttle is thrown with one hand in at one side of the warp, and received with

Fig. 2.

Weaving.

with the other hand at the other side, it is obvious, that when the web is of a breadth too great for a man to reach from one side of it to the other, two workmen must be employed and much time lost. To remedy this inconveniency, a new shuttle has, in this country, been lately brought into very general use, and called the *flying shuttle*, because it flies through the warp with wonderful rapidity on two steel rollers RR (fig. 3.). This shuttle is not thrown with the hand, but moved backwards and forwards by a very simple piece of machinery, of which fig. 4. will give the reader a sufficiently accurate conception. To each end of the *batten* or *lay* L is fastened a kind of open box B, *b*, with the bottom or horizontal side exactly on a level with the threads of the warp of the intended web. In each of these boxes is a vertical piece of wood D, *d*, of considerable thickness, called a *driver*. This driver is moved easily on an iron spindle or axis from one end of the box to the other by means of a slender rope CCCD, and a handle H is seen in the figure. When the weaver is to begin his work, he lays the shuttle on its rollers in the box B with the iron tip T (fig. 3.) touching, or almost touching, the driver D (fig. 4.). Then moving the handle H, with a sudden jerk, towards the box *b*, the driver D forces the shuttle with a rapid motion through the warp till it strikes *d*, which is impelled by the stroke to the further end of the box *b*. The two drivers D and *d* have now changed their positions in their respective boxes; so that the driver which was at the front of its box before, is now at the further end of it, and *vice versa*. Then by a sudden jerk of the hand towards B the shuttle is driven back till it strike D; and thus is the work continued without the weaver having occasion ever to stretch his arms from one margin of the web to the other. That the shuttle may not, by the unsteadiness of the workman's hand, be driven *zig-zag* through the warp or out of the place in which it ought to move, the guiding or driving rope CCCD is made to pass through smooth holes or loops C, C, at the ends of the ropes EC, EC, suspended either from the cross bar on the top of the loom or from the swords of the batten.

Fig. 3. Fig 4.

This shuttle, we should think, a great improvement in every kind of weaving-loom, though some of the older tradesmen, with whom we have conversed on the subject, contend, that it is valuable only in what they call light work, such as cotton or linen cloth, or when the web, if woollen, is very broad.

But as the labour of weaving is pretty severe, Mr Robert Millar, an ingenious calico-printer in the county of Dumbarton, Scotland, wishing to lessen it, invented, some years ago, a weaving-loom, which may be wrought by water, steam, horses, or any other power, for which invention he received a patent in 1796. The following is his own description of his patent weaving-loom:

Fig. 5. Fig. 5. represents a side view of the loom, AA, BB, CC, DD, being the frame. *a* is an axis (which we shall call the spindle) across the frame. On this axis is a sheeve *b*, two inches thick, having a groove round it, two inches deep, and half an inch wide. The bottom of this groove is circular, except in one part *c*, where it is filled up to the top; a lever *d* rests on the bottom of this groove, and is lifted up by it when the elevation *c* comes round to the situation represented in the figure. By this motion, the lever *d* acts on the ratchet-wheel *e* by the catch *t*, and draws it forward one tooth, each revolution of the sheeve. This ratchet wheel is in an iron frame *g g*, which also properly carries the two catches *t* and *u*, which are connected with it at *v*. The catch *u* holds the ratchet-wheel in its position, while the lever *d* and the catch *t*, are moved by the groove *c* in the sheeve. On the arbor of the ratchet is a small pinion *h*, working in the wheel *f*; this wheel is fixed on the end of the roller *e* of fig. 7. On the side of the sheeve *b* is fixed a wiper *k*, which lifts the treadle *l*. This treadle turns on its joints in the sheeve E, which is fixed to the side of the frame A and D; it is kept pressing on the bottom of the groove in the sheeve by a spring *m*, fixed to the frame side A, and having a slender rod *n* from its extremity, joining it with the treadle at *l*. From the point of the treadle there goes a belt *o*, which passes over the pulley *p*, which is seen edgewise in this figure, and is joined to the top of the fly pin *q*, of fig. 6. At the end of the frame A is the short post F; on this rests the yarn-beam *j*, having a sheeve *r*, over which passes a cord, having a weight *s* suspended to it. The other end of this cord is fastened to the spring *v*; the weight causes the yarn-beam to stretch the web from the ratchet-wheel *e*, with its catch *u*; and the spring *v* allows the rope to slide on the sheeve as the ratchet is drawn round during the working.

Fig. 6. Fig. 6. is a front view of the loom. *a a* is the spindle which carries the sheeve *b*, and the wipers *d* and *d*, which move the treadles *w*, *w*, of fig. 5. These use the treadles of the headles, with which they are connected by cords from the shafts of the headles *s*, *s*. From the upper shaft there go two leathern belts *f*, *f*, to the roller *y*, furnished each with a buckle, for tightening them at pleasure. The two wipers *c*, *c*, on the shaft *a*, which serve for taking back the lay, have the two treadles, *x*, *x*, in fig. 7. with a belt from each passing over the roller *h* 2 of fig. 6. and fixed to the sword of the lay. From the swords of the lay forward is fixed a belt to each end of the roller *i*; from this roller there goes a cord to the spring *j*, which serves for taking forward the lay which is hinged on the rocking-tree *t*. The star-wheel *b* of fig. 3. and the sheeve *b* of fig. 1. are fixed to the opposite ends of the spindle *a* without the frame; and both the wheel and sheeve have a wiper *k* fixed to them for moving the treadles. In order to drive the shuttle, the belts *o*, *o*, go from the points of the treadles, over the pulleys *p*, *p*, to the top of the fly-pin *q*. This turns on a pin joint in a rail *r*, which goes across the loom. From its lower end there go two small cords to the shuttle drivers *g*, *g*, which slide on the iron rods *n*, *n*. A long iron rod *v* goes across the lay, and is hung on two centres at the ends. In this rod *v* are fixed two small crooked wires *w*, *w*, which are more distinctly marked in the little figure *w* above, which represents a section of the lay. The dot at the lower end of the wire *w*, in this figure, is the section of the rod *v*. The shuttle passes between these wires and the lay every shot, and lifts them up, causing the rod *v* to turn round a little. But if the shuttle should not pass these wires, nor lift them, it would be drawn home by the lay, and destroy the web. To prevent this, there is fixed on one end of the rod *v* a stout crooked wire *z*, having a broad or flat head, which naturally rests on a plate of iron, marked and fixed to the back of the lay. This plate has a slit in

its

Weaving. its middle about an inch deep. In this slit rests the rod *a* 2 of fig. 7. on which is a short stud, which is caught by the wire *z* when the wire *w* is not lifted back by the passing shuttle. This will stop the lay from coming home, and will set off the loom.

Fig. 7. Fig. 7. is another side view of the loom opposite to fig. 5. On the spindle *a* is the star wheel *b*, on the outside of the loom frame, on the arms of which wheel is fixed the wiper *k*, as the similar wiper is fixed to the sheeves on the other end of the spindle. The wipers which drive the shuttles are fixed on opposite squares of the spindle, and work alternately. Below the star-wheel is a pinion *c*, which is on a round spindle, turned by the water-wheel, by means of a wheel on this spindle. In a wheel on this spindle are two studs, on which the pinion *c* slides off and on, as the loom is set off and on by the lever *d*. At the farther end of this lever is the weight *s*, hanging by a chord which passes over a pulley *t*, fixed at the outer end of the spring-catch on which the lever *d* rest; and thus the loom is drawn in at the upper end of the lever *d*. But when the shuttle does not lift the wire *z*, it catches on the stud on the rod *a* 2, which is connected with the spring-catch, and the lever *d* flies off with the weight *s*, and the loom stops working. On the head of the post F is the yarn-beam. The rollers *e* and *f* are cylinders, pressed together by a screw-lever, and take away the cloth between them at a proper rate. In the roller *f* is a groove for a band for driving the roller *g*, on which the cloth winds itself as it is wrought. Wherever springs are mentioned to be used in the above description, weights may be used in their stead, and to the same effect, and more especially upon the treadle of fig. 5. for driving the shuttle.

Fig. 8. Fig. 8. is a representation of a ribband loom. 1. Is the frame of the loom. 2. The castle, containing 48 pulleys. 3. The branches, on which the pulleys turn. 4. The tires, or the riding-cords, which run on the pulleys, and pull up the high-lisses. 5. The list-sticks, to which the high-lisses are tied. 6. The high-lisses, or lists, are a number of long threads, with platines, or plate-leads at the bottom; and ringlets, or loops, about their middle, through which the cords or cross-threads of the ground-harness ride. 7. The plate-leads, or platines, are flat pieces of lead, of about six inches long, and three or four inches broad at the top, but round at the bottom; some use black slates instead of them: their use is to pull down those lisses which the workman had raised by the treadle, after his foot is taken off. 8. The branches or cords of the ground harness, which go through the loops in the middle of the high-lisses: on the well ordering of these cords chiefly depends the art of ribbon-weaving, because it is by means of this contrivance that the weaver draws in the thread or silk that makes the flower, and rejects or excludes the rest. 9. The batton: this is the wooden frame that holds the reed or shuttle, and beats or closes the work: where observe, that the ribbon-weaver does not beat his work; but as soon as the shuttle is passed, and his hand is taken away, the batton is forced, by a spring from the top, to beat the work close. 10. The shuttle, or reed. 11. The spring of the batton, by which it is made to close the work. 12. The long-harness are the front-reeds, by which the figure is raised. 13. The linguas are the long pieces of round or square lead, tied to the end of each thread of the long-harness to keep them tight. 14. The broad piece of wood, about a foot square, leaning somewhat forward, intended to ease the weaver as he stoops to his shuttle; it is fixed in the middle of the breast-beam. Some weavers, instead of this, have a contrivance of a cord or rope that is fastened to the front-frame, and comes across his breast; this is called a *stopfall*. 15. The seat-bench; this leans forward very much. 16. The foot-step to the treadles. 17. The breast-beam, being a cross-bar that passes from one of the standards to the other, so as to front the workman's breast: to this breast-bar is fixed a roll, upon which the ribbon passes in its way, to be rolled upon the roller, that turns a little below. 18. The clamps, or pieces of wood, in which the broaches that confine the treadles rest. 19. The treadles are long narrow pieces of wood, to the ends of which the cords that move the lisses are fastened. 20. The treadle-cords are only distinguished from the riding-cords by a board full of holes, which divide them, in order to prevent the plate-leads, which are tied to the high-lisses, from pulling them too high when the workman's foot is off the treadle: which stop is made by a knot in the treadle-cord, too big to be forced through that hole in the board. 21. The lams are two pieces of thin narrow boards only used in plain works, and then to supply the place of the long-harness. 22. The knee-roll, by which the weaver rolls up his ribbon as he sees proper, or by bit and bit as it is finished. 23. The back-rolls, on which the warp is rolled. It is to be observed, that there is always as many rolls as colours in the work to be wove. 24. The clamps, which support the rollers. 25. The returning-sticks, or, as others call them, the *returns*, or the *tumblers*, or *pulleys*, to which the tiers are tied, to clear the course of cords through the high-lisses. 26. The catch-board for the tumblers. 27. The tire-board. 28. The buttons for the knee-rolls and treadle-board, described in N° 20.

It is stated in the proceedings of the National Institute of France, that a report was presented to that body concerning a new machine for weaving ribbed stockings. The advantages which this machine possesses are said to be, that it may be erected at one half of the expence of the English stocking frame, and that its movements are much lighter. The experience of its operations for two years has confirmed these advantages. Of the nature and construction of this machine we have had no opportunity of obtaining any information; but we thought it worth while to insert this short notice, with the view of directing the attention of such of our readers as may be interested in the improvement of such manufactures.

Web. WEB, a sort of tissue or texture formed of threads interwoven with each other; some whereof are extended in length, and called the *warp*; others are drawn across, and called the *woof*.

WEBERA, a genus of plants belonging to the class and order pentandria monogynia. See BOTANY *Index*.

WEBSTER, ALEXANDER, D. D. was the son of James Webster, minister of the Tolbooth church in Edinburgh, and born in that city about the year 1707. He was only 13 years of age at the death of his father, and of course could derive little from parental instruction or example. He studied at the university of Edinburgh the several branches of learning with great approbation, particularly

Fig. 1.

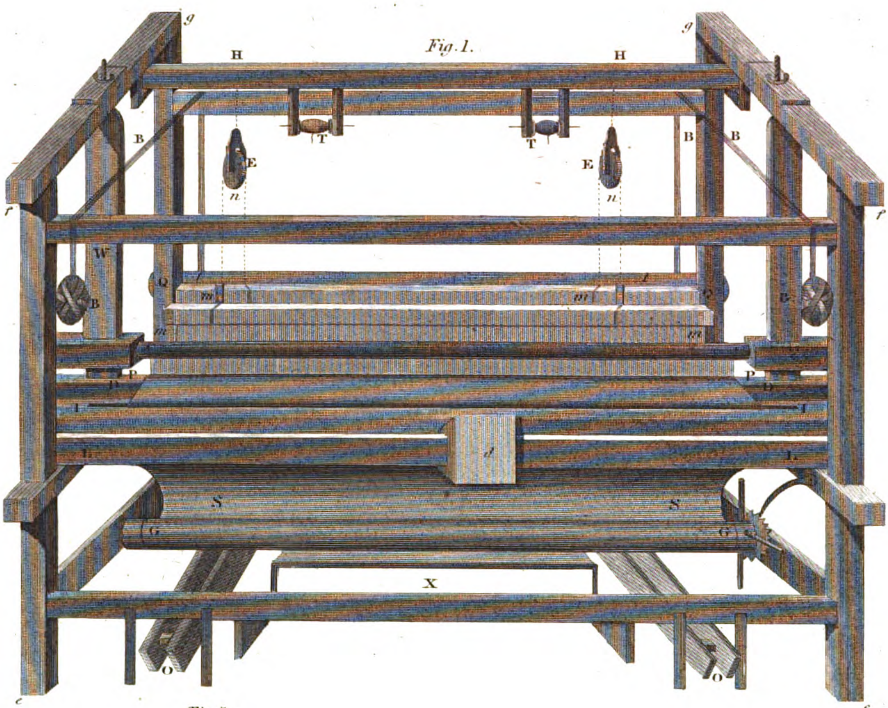


Fig. 3.

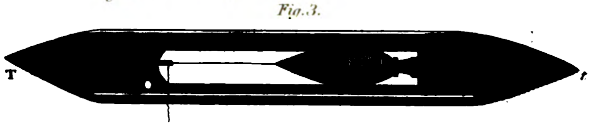


Fig. 2.

Fig. 4.

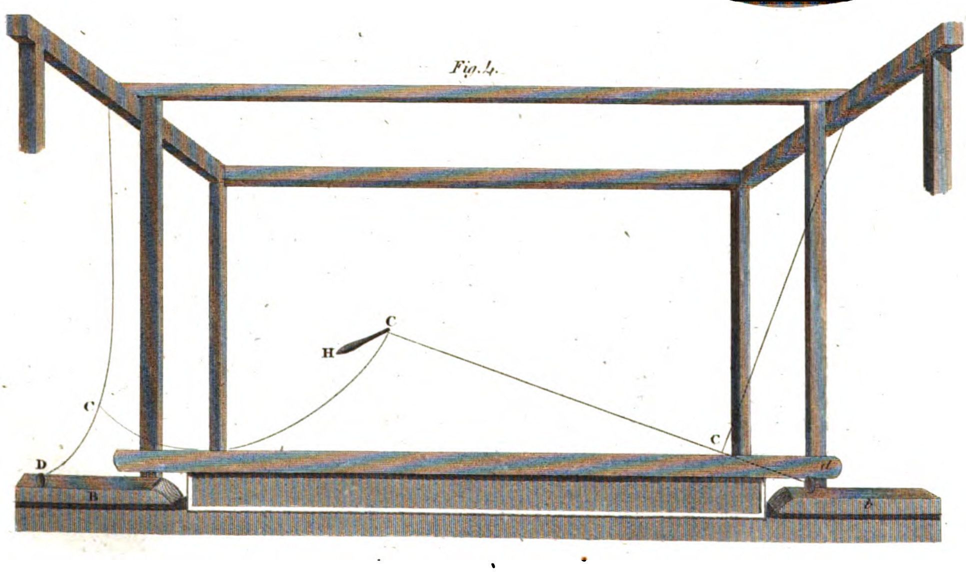


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Fig. 5.

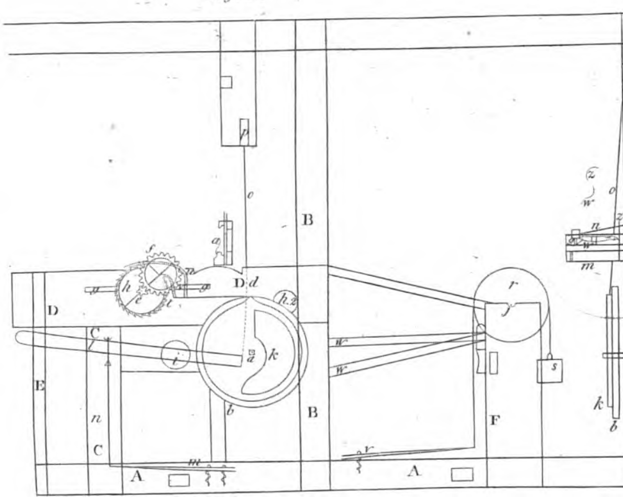


Fig. 6.

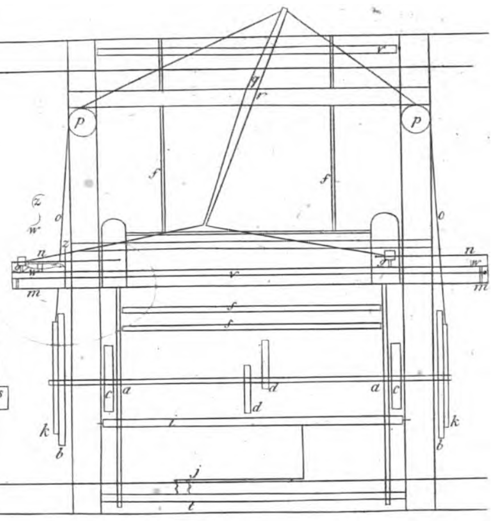


Fig. 7.

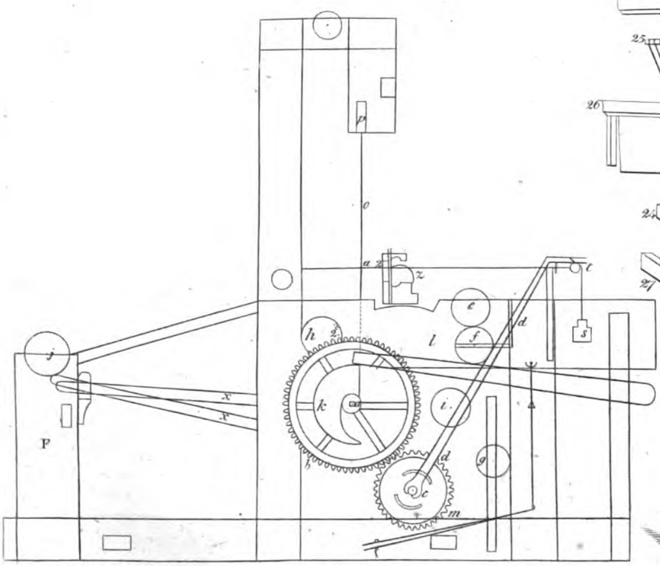
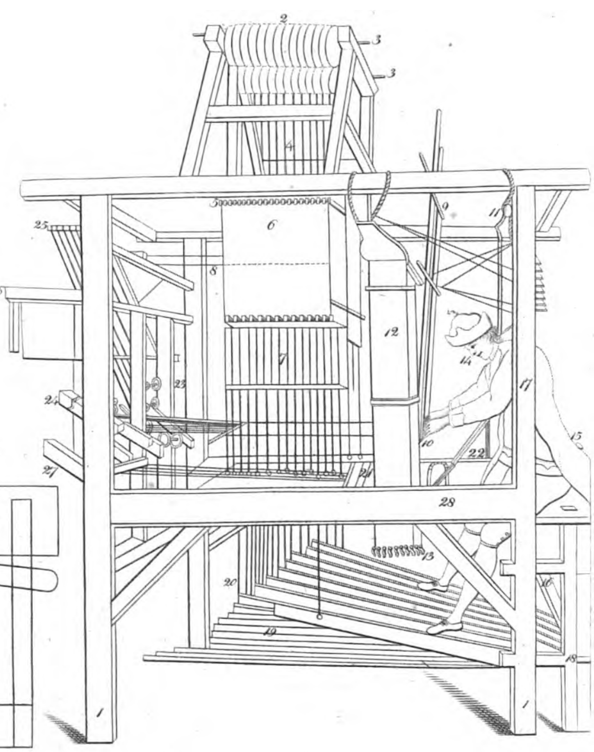


Fig. 8.



Webster. particularly those connected with the mathematics, for which he discovered an early predilection. He afterwards attended the lectures of the professor of divinity, and in the year 1733 he was ordained minister of the parish of Culross, and in June 1737, he was admitted to be one of the ministers of the Tolbooth church of Edinburgh. His eloquence was noble and manly, his piety conspicuous, and the discharge of his pastoral duties faithful and laborious. To these qualities he added an enlightened zeal for the external interests of the church, a jealousy of corruption, a hatred of false politics and tyrannical measures, which sometimes exposed him to calumny from the guilty, but secured him the esteem of all who could value independence of soul and integrity of heart.

The prosperity of fortune which placed Mr Webster in the church of his father, and restored him to the polished society of his native city, was not confined to these favours. Eleven days after his settlement in Edinburgh, he obtained the hand of Mary Erskine, a young lady of considerable fortune, and nearly related to the noble family of Dundonald. The genius of Mr Webster now began to unfold itself. Family connections extended his acquaintance with the nobility. Edinburgh then possessed a number of men, both in civil and ecclesiastical stations, who have saved or adorned their country. With these he was soon to co-operate in defending the Protestant interests from the arms and artifices of rebellion.

In the year 1733, five or six ministers seceded from the church, and being anxious to draw away as many as possible from the communion which they had renounced, they invited down to Scotland in 1741, Mr George Whitefield, a young preacher of great piety and extraordinary pulpit talents. On his way to Dunfermline, he was met and entertained at Edinburgh by Mr Webster and some of his brethren. From them he learned the state of church parties in Scotland; and though he kept his promise of preaching first in Fife, he declined connecting himself with any particular sect. Disappointed of his influence and assistance, the Seceders ascribed the effects of his preaching to sorcery and the devil, while Mr Webster, in a pamphlet which he published on the occasion, attributed them to the influence of the Holy Spirit, an opinion regarded by the Seceders as unspeakable wickedness.

In the year 1745, Mr Webster remained in the city when it was taken by the rebels, and employed his universal popularity and vigorous eloquence in retaining the minds of the people in the interests of the house of Hanover. His exertions in this were not overlooked by most of the spirited gentlemen who acted in quelling the rebellion. He became an intimate friend of Duncan Forbes of Culloden, Lord Milton, and others.

He preserved to the latest period of his career, that activity both of mind and body, which distinguished him in the prime of life, obtaining at last his frequent wish and prayer, an easy and peaceful death, after a very short indisposition, on the 25th of January 1784. His remains were deposited in the Grayfriars church-yard; and it is not a little remarkable that neither private friendship nor public generosity has yet come forward to testify its regard for two of the most eminent characters of the church of Scotland. The ashes of Webster and Blair repose in the same cemetry, undistinguished from the less illustrious dead. No monumental stone marks the place of their dust.

Webster ‖ Weeks.

Nature endowed Mr Webster with strong faculties, which were afterwards improved by a considerable share of erudition. He was a master in the knowledge of the world and of human nature; his address was engaging; his wit strong as his mind; his convivial powers, as they are called, enchanting. He had a constitutional strength against intoxication, which made it dangerous in most men to attempt bringing him into such a state. His character as a minister was popular in the extreme. His voice was harmonious, and his figure noble. To the poor he was a father and a friend, a liberal patron to poor students. In his person he was tall, and of a thin and meagre habit. His features were strongly marked, and the conformity of the whole indicated genius and independence.

To him the widows of the clergy are indebted for the establishment of the celebrated *Scheme*, the plan of which he matured in his mind soon after he was appointed a minister of the Tolbooth church. By it the widows of ministers are entitled to the annual sum of 10, 15, 20, or 25 pounds, according as the clergy pay into the fund yearly, 2l. 12s. 6d.—3l. 18s. 9d.—5l. 5s. or 6l. 11s. 3d, or to their children in sums of 100—150—200—or 250l. in favour of which an act of parliament was obtained in terms of a petition (17 Geo. II.) with liberty to employ the surplus of the annual payments and expences in loans of 30l. each among the contributors, and to put out the remainder at interest, on proper security. A second act was procured in the 22d year of the same reign (1748) granting liberty to raise the capital to 80,000l. including the sums lent to contributors. The fund is conceived to commence from the 25th March 1744. This was followed by another act in the year 1770, discontinuing the loan granted to contributors, and granting liberty to raise the capital to 100,000l.; and the whole economy of the institution was then fixed and determined, a report of the state of the fund being ordered to be made annually to the General Assembly by the trustees, which was to be afterwards printed. The success of the scheme has been complete.

WEDGE, one of the mechanical powers. See MECHANICS.

WEDNESDAY, the fourth day of the week, so called from a Saxon idol named *Woden*, supposed to be Mars, worshipped on this day.

Ash-WEDNESDAY, the first day of Lent, so called from the custom observed in the ancient Christian church of penitents expressing their humiliation at this time, by appearing in sackcloth and ashes.

WEED, a common name for all rank and wild herbs, that grow of themselves, to the detriment of other useful herbs they grow among.

WEED, in the miners language, denotes the degeneracy of a load or vein of fine metal into an useless marcasite.

WEEDS, also denote a peculiar habit, worn by the relicts of persons deceased, by way of mourning.

WEEK, in chronology, a division of time comprising seven days. See *PLANETARY Days* and SABBATH.

Passion-WEEK, or the *Holy WEEK*, is the last week in Lent, wherein the church celebrates the mystery of our Saviour's death and passion.

Weeks, Ember. See Ember.

Feast of Weeks. See Pentecost.

WEEVER. See Trachinus, Ichthyology *Index.*

WEEVIL, in *Zoology*, a species of curculio. See Curculio, Entomology *Index;* and for the method of destroying this troublesome and destructive insect, see Granary and Vermin.

WEIGELIA, a genus of plants belonging to the class and order pentandria monogynia. See Botany *Index.*

WEIGH, a weight of cheese, wood, &c. containing 256 pounds avoirdupois. Of corn, the weigh contains 40 bushels; of barley or malt, six quarters. In some places, as Essex, the weigh of cheese is 300 pounds.

WEIGHING, the act of examining a body in the balance to find its weight.

Weighing Anchor, is the drawing it out of the ground it had been cast into, in order to set sail, or quit a port, road, or the like.

WEIGHT, in *Physics*, a quality in natural bodies, whereby they tend downwards towards the centre of the earth. Or, weight may be defined in a less limited manner, to be a power inherent in all bodies, whereby they tend to some common point, called the *centre of gravity*, or, to speak more accurately, to one another: and that with a greater or less velocity, as they are more or less dense, or as the medium they pass through is more or less rare. See Mechanics.

Weight, in commerce, denotes a body of a known weight appointed to be put in the balance against other bodies whose weight is required.

The security of commerce depending, in a good measure, on the justness of weights, which are usually of lead, iron, or brass, most nations have taken care to prevent the falsification thereof, by stamping or marking them by proper officers, after being adjusted by some original standard. Thus, in England, the standard of weights is kept in the exchequer by a particular officer, called the *clerk of the market.*

Weights may be distinguished into the ancient and modern.

I. Ancient Weights.

1. Those of ancient Jews, reduced to the English troy weight, will stand as in the following table:

			lib.	oz.	dwt.	gr.
Shekel			0	0	9	$2\frac{4}{7}$
60	Maneh		2	3	6	$10\frac{2}{7}$
3000	50	Talent	113	10	1	$10\frac{2}{7}$

2. Roman weights, reduced to English troy weight, will stand as in the following table:

										oz.	dwt.	gr.
Lentes										0	0	$0\frac{85}{112}$
4	Siliquæ									0	0	$3\frac{1}{28}$
12	3	Obolus								0	0	$9\frac{3}{28}$
24	6	2	Scriptulum							0	0	$18\frac{3}{14}$
72	18	6	3	Drachma						0	2	$6\frac{9}{14}$
96	24	8	4	$1\frac{1}{3}$	Sextula					0	3	$0\frac{6}{7}$
144	36	12	6	2	$1\frac{1}{2}$	Sicilicus				0	4	$13\frac{2}{7}$
192	48	16	8	$2\frac{2}{3}$	2	$1\frac{1}{3}$	Duella			0	6	$1\frac{5}{7}$
576	144	48	24	8	6	4	3	Uncia		0	18	$5\frac{1}{7}$
6912	1728	576	288	96	72	48	36	12	Libra	10	18	$13\frac{5}{7}$

The Roman ounce is the English avoirdupois ounce, which they divided into seven denarii, as well as eight drachmas.

3. *Attic Weights.*

			English Troy Weight. lb.	oz.	dwt.	gr.
Drachma			0	0	2	16.9
100	Mina		1	1	10	10
6000	60	Talent	67	7	5	0

II. Modern Weights.

1. *English Weights.*—Mr Renardson, in a paper published in the Philosophical Transactions, has proved, that at first there was but one weight in England, and that this was the avoirdupois. Troy weight was introduced in the time of Henry VII.: At present, both the troy and avoirdupois weights are used in England. Troy weight seems to have derived its name from *Troyes*, a town in France, where a celebrated fair was kept. It is used for weighing gold, silver, jewels, silk, and all liquors. The avoirdupois is used for weighing other things.

Table of Troy Weight, as used by the

Goldsmiths, &c.

Grains.			
24	Penny-weights.		
480	20	Ounce.	
5760	240	12	Pound.

Apothecaries.

Grains.				
20	Scruple. ℈			
60	3	Dram. ʒ		
480	24	8	Ounce. ℥	
5760	288	96	12	Pound.

The troy pound in Scotland, which by statute is to be the same as the French pound, is commonly supposed equal

equal to 15 ounces and three quarters troy English weight, or 7560 grains. But by a mean of the standards kept by the dean of guild of Edinburgh, it weighs 7599$\frac{2}{31}$ or 7600 grains.

Table of Avoirdupois Weight.

Drams.					
16	An ounce.				
256	6	A pound.			
7168	448	28	A quarter.		
28672	1792	112	4	A hundred.	
573440	35840	2240	80	20	A ton.

The avoirdupois pound is equal to 7004 troy grains, the avoirdupois ounce to 437.75 grains; and it follows of consequence, that the troy pound is to the avoirdupois ounce as 88 to 107 nearly; for as 88 to 107, so is 5760 to 7003.636: that the troy ounce is to the avoirdupois ounce as 80 to 73 nearly; for as 80 to 73, so is 480 to 438. An avoirdupois pound is equal to 1 lb. 2 oz. 11 dwts. 20 gr. troy; a troy ounce is equal to 1 oz. 1.55 dr. avoirdupois; an avoirdupois dram contains 27.34375 grains; 175 troy pounds are equal to 144 avoirdupois pounds.

The moneyers have a peculiar subdivision of the grain troy: thus,

$$\text{The}\left\{\begin{array}{l}\text{Grain}\\ \text{Mite}\\ \text{Droit}\\ \text{Periot}\end{array}\right\}\text{into}\left\{\begin{array}{l}\text{20 Mites.}\\ \text{24 Droits.}\\ \text{20 Peroits.}\\ \text{24 Blanks.}\end{array}\right.$$

The English weights are used in the United Provinces of America.

2. *French Weights.*—Different weights were formerly used in most of the different provinces of France: These, however, have undergone very material alterations since the revolution in that kingdom. See **Measure**. But as a knowledge of the ancient weights of that country is of importance, on account of the books in which they are used, we insert the following tables. The Paris pound contains 16 ounces, and is divided two ways.

Grains.					
24	Penny-weight.				
72	3	Gros.			
576	24	8	Ounce.		
4608	192	64	8	Marc.	
9216	384	128	16	2	Pound.

Half ounce.						
2	Ounce.					
4	2	Half-quarter pound.				
8	4	2	Quarter-pound.			
16	8	4	2	Half-pound.		
32	16	8	4	2	Pound.	
3200	1600	800	400	200	100	Quintal.

The weights of the first division are used to weigh gold, silver, and the richer commodities; and the weights of the second division for commodities of less value.

The Paris 2 marc, or pound weight, is equal to 7560 grains troy, and the Paris ounce equal to 472.5 grains troy.

	lb.	oz.	dwt.	gr.	
The Paris pound =	1	3	15	0	troy.
The Paris ounce =	0	9	19	16.5	troy.

A grain troy = 1.2186507 of a Paris grain.

But the pound was not the same throughout France. At Lyons, *e. gr.* the city pound was only 14 ounces: so that 100 Lyons pounds, made only 86 Paris pounds. But beside the city pound, they had another at Lyons for silk, containing 15 ounces. At Thoulouse, and throughout the Upper Languedoc, the pound was 13 ounces and a half of Paris weight. At Marseilles, and throughout Provence, the pound was 13$\frac{1}{3}$ ounces of Paris weight. At Rouen, beside the common Paris pound and mark, they had the weight of the vicomte; which was 16 ounces, a half, and five-sixths of the Paris weight. The weights enumerated under the two articles of English and French weights are the same that are used throughout the greatest part of Europe; only under somewhat different names, divisions, and proportions.

French weights were formerly used in all the French American settlements.

3. *Dutch Weights.*—The weight used in Amsterdam and all over Holland is called *Troy weight*, and is exactly the same with that used at Brussels. The Dutch weights are as follows:

Deuskens.						
2	Troyken.					
4	2	Vierling.				
16	8	4	As.			
512	256	128	32	Angle.		
10240	5120	2560	640	20	Ounce.	
81920	40960	20480	5120	160	8	Marc.

The marc is equal, according to M. Tillet, to 4620 French grains.

Weight.

The Amsterdam pound used in commerce is divided into 16 ounces, 32 loots, or 128 drams. This pound contains 2 marcs troy, and ought therefore to weigh only 10240 *as*: but it weighs 10280; so that it is a little heavier than the troy pound of Amsterdam: 256lb. of commerce are equal to 257lb. troy of Holland. Two different pounds are used by apothecaries; the one containing 2 marcs, the other only $1\frac{1}{2}$. The first is called *arsenic* pound weight; it contains 16 ounces, the ounce 8 drams, the dram 8 scruples, the scruple 20 grains. The second is called the *apothecary's* pound; it is divided into 12 ounces, or 24 loots. Three arsenic pounds are equal to 4 apothecary's pounds.

The Dutch stone	=	8 commercial lb.
The Lispundt, or Ll.	=	15
The hundred weight	=	100
The Schippondt, or Sch. lb.	=	300

4. *Spanish Weights.*—The marc of Castile, used for weighing gold and silver, is divided as follows:

Grains (gold weight).	Grain (silver weight).	Tomine (gold weight).	Tomine (silver weight.)	Adarme.	Ochava.	Castellano.	Ounce.	Marc.
$1\frac{1}{24}$	Grain (silver weight).							
12	$11\frac{13}{25}$	Tomine (gold weight).						
$12\frac{1}{2}$	12	$1\frac{1}{24}$	Tomine (silver weight.)					
$37\frac{1}{2}$	36	$3\frac{1}{8}$	3	Adarme.				
75	72	$6\frac{1}{4}$	6	2	Ochava.			
96	$92\frac{4}{25}$	8	$7\frac{17}{25}$	$2\frac{14}{25}$	$1\frac{7}{25}$	Castellano.		
600	576	50	48	16	8	$6\frac{1}{4}$	Ounce.	
4800	4608	400	384	128	64	50	8	Marc.

The marc, according to Tillet, is equal to 7 oz. 4 gros, 8 grains French, which is equal to 4785 *as* of Holland. One hundred marcs of Castile = about $93\frac{1}{2}$ marcs of Holland; 100 marcs of Holland = 107 marcs of Castile. Medicines are sold by the same marc; but it is divided differently, containing 8 ounces, 64 drachms, 192 scruples, 384 obolos, 1152 caracteras, 4608 grains.

The Spanish commercial pound is divided into two marcs, called *marcs of Tejo*, each of which is equal to the marc of Castile. This pound is divided into 16 ounces, 256 adarmes, 9,216 grains.

5. *Weights of Portugal.*—The Lisbon marc for essaying silver coin of 12 deniers, and the denier of 24 grains. The marc of Portugal for weighing gold and silver is equal, according to Tillet, to 7 ounces $3\frac{1}{2}$ gros, and 34 grains French, which makes 4776 *as* of Holland; so that it is exactly the same with the Lisbon pound. It is divided into 8 ounces, 64 outavas, 192 scruples, 4608 grains.

The pound consists of 2 marcs, 16 ounces, or 96 outavas; the arroba of 32 lb.; the quintal of 4 arrobas, or 128 lb. 100 Oporto pounds make $87\frac{1}{8}$th pounds of commerce of Amsterdam.

6. *Weights of Italy.*—*Genoa.* Two kinds of weights

are used at Genoa, the *peso grosso* (heavy weight), and the *peso sottile* (light weight): the latter is used for weighing gold and silver, the former for other things. The pound of the peso sottile is equal, according to Tillet, to 1 marc, 2 ounces, $2\frac{1}{2}$ gros, 30 grains French. It is divided into 8 ounces, the ounce into 24 deniers, and the denier into 24 grains. The pound of the peso grosso is equal to 1 marc, 2 ounces, 3 gros, 5 grains, French. It is divided into 12 ounces:

The cantaro	=	100 lbs. peso grosso.
The rubbo	=	25 lbs.
The rotolo	=	$1\frac{1}{2}$ lb.
100 lbs. peso grosso	=	$64\frac{1}{7}$ lb. of commerce of Amsterdam.
100 lbs peso sottile	=	129 marcs troy of Holland.

Rome. The Roman pound consists of 12 ounces, the ounce of 24 deniers, the denier of 24 grains. The Roman pound, according to Tillet, is equal to 1 marc, 3 ounces, $\frac{1}{2}$ gros, 14 grains, French.

Venice. The marc for weighing gold and silver contains 8 ounces, 32 quarti, 1152 carati, or 4608 grani. An hundred marcs of Venice = $97\frac{1}{5}$ marcs troy of Holland, 100 marcs of Holland = 103 of Venice. In Venice they also use a *peso grosso* and *peso sottile.* 100 lbs. peso grosso = $94\frac{4}{5}$ commercial lbs of Amsterdam. 100 lbs. peso sottile = $61\frac{2}{7}$ ditto.

7. *Swedish Weights.*—The marc for weighing gold and silver is equal to 16 lods, 64 quentins, or 4384 as. The pound of 32 lods, used for weighing food, is equal, according to Tillet, to 1 marc, 5 ounces, 7 gros, 8 grains French, which makes $8848\frac{1}{2}$ as troy of Holland. This answers exactly to the weight of the different pounds, as fixed in Sweden, viz. 8848 as = the pound for weighing articles of food; $7821\frac{79}{125}$ as = marc used in the mines; $7450\frac{2}{125}$ as = marc used in towns and in the country; $7078\frac{2}{5}$ as = marc used for weighing iron; 7416 as = pound used in medicine.

The skippund	=	400 lbs. for weighing food.
The centner	=	120 lbs.
The waag	=	165 lbs.
The sten	=	32 lbs.
The Swedish as	=	1 as of Holland troy.

8. *German Weights.*—*Vienna.* The marc of Vienna for weighing gold and silver is divided into 16 loths, 64 quintals, or 256 deniers or pfenings; the loth into 4 quintals, or 16 pfenings. This marc, according to Tillet, is equal to 1 marc, 1 ounce, 1 gros, 16 grains, French, = 5831 as troy Holland. The pound of Vienna is divided into 2 marcs, or 4 viertings; the mark into 8 ounces, 16 loths, 64 quintals, or 266 pfenings.

Hamburgh. The marc for essaying gold is divided into 24 carats; the carat into 12 grains. The marc for silver is divided into 16 loths, and the loth into 18 grains. These marcs consist each of 288 grains, and are therefore equal. This marc, used in Hamburgh for gold and silver, is the marc of Cologne, which is equal, according to Tillet, to 7 ounces, 5 gros, $7\frac{1}{2}$ grains, French, = 4866 as troy of Holland. It is divided into 8 ounces, 16 loths, 64 quentins, 256 pfenings, 4352 esches, or 65536 richt pfenings theile. The apothecary pound used in Hamburgh, and almost all Germany, is divided into 12 ounces, 96 drachms, 288 scruples, or 5760 grains; an ounce is equal to 621 as of Holland.

The

Weight.

The pound of commerce is equal, according to Tillet, to 10085 as of Holland; for half a pound is equal to 7 ounces, 7 gros, 23 grains, French. This pound is divided into 16 ounces, 32 loths, 128 quentins, or 512 pfenings.

9. *Russian Weights.*—The berckowitz = 400 lbs.
The poud . - - - - = 40 lbs.

The pound is divided into 32 loths, or 96 solotnuks. One hundred Russian lbs. = $166\frac{1}{2}$ marcs, or $82\frac{4}{5}$ lbs. of Amsterdam. One hundred lbs. of commerce of Amsterdam = $120\frac{3}{4}$th lbs. of Russia.

10. *Weights used in the several parts of Asia, the East Indies, China, Persia, &c.*—In Turkey, at Smyrna, &c. they use the batman, or battemant, containing $7\frac{1}{2}$ occos; the occo contains 4 chekys or pounds, each of which, according to Tillet, is equal to 1 marc 2 oz. 3 gros. 28 gr. French. The Turkish weights are divided as follows:

Cantaras.	Batmans.	Occos.	Rotolos.	Chekis.	Mescals.	Drachms.
1 =	$7\frac{1}{2}$ =	44 =	100 =	176 =	$11733\frac{1}{3}$ =	17600
	1 =	6 =	$13\frac{1}{11}$ =	24 =	1600 =	2400
		1 =	$2\frac{1}{11}$ =	4 =	$266\frac{2}{3}$ =	400
			1 =	$1\frac{19}{28}$ =	$117\frac{1}{3}$ =	176
				1 =	$66\frac{2}{3}$ =	100
					1 =	$1\frac{1}{2}$

At Aleppo there are three sorts of rottos; the first 720 drachms, making about 7 pounds English, and serving to weigh cottons, galls, and other large commodities; the second is 680 drachms, used for all silks but white ones, which are weighed by the third rotto of 700 drachms. At Seyda the rotto is 600 drachms.

The other ports of the Levant, not named here, use some of these weights; particularly the occa, or ocqua, the rottoli, and rotto.

The Chinese weights are, the piece for large commodities: it is divided into 100 catis or cattis, though some say into 125; the cati into 16 taels or tales, each tael equivalent to $1\frac{1}{5}$ of an ounce English, or the weight of one rial and $\frac{1}{12}$, and containing 12 mas or masses, and each mas 10 condrins. So that the Chinese piece amounts to 137 pounds English avoirdupois, and the cati to 1 pound 8 ounces. The picol for silk containing 66 catis and $\frac{1}{3}$; the bahar, bakaire, or barr, containing 300 catis.

Tonquin has also the same weights, measures, &c. as China. Japan has only one weight, viz. the cati; which, however, is different from that of China, as containing 20 taels. At Surat, Agra, and throughout the states of the Great Mogul, they use the man, or maund, whereof they have two kinds; the king's maund, or king's weight; and the maund simply; the first used for the weighing of common provisions, containing 40 seers, or serres; and each seer a just Paris pound. The common maund, used in the weighing of merchandise, consists likewise of 40 seers, but each seer is only estimated at 12 Paris ounces, or $\frac{3}{4}$ of the other seer.

The maund may be looked upon as the common weight of the East Indies, though under some difference of name, or rather of pronunciation; it being called *mao* at Cambaya, and in other places *mein* and *maun*. The seer is properly the Indian pound, and of universal use; the like may be said of the bahar, tael, and catti, above mentioned.

Weight.

The weights of Siam are the piece, containing two shans or cattis; but the Siamese catti is only half the Japanese, the latter containing 20 taels and the former only 10; though some make the Chinese catti only 16 taels, and the Siamese 8. The tael contains 4 baats, or ticals, each about a Paris ounce; the baat 4 selings or mayons; the mayon 2 fouangs; the fouang 4 payes; the paye 2 clams; the sompaye half a fouang.

It is to be observed, that these are the names of their coins as well as weights; silver and gold being commodities there sold, as other things, by their weights.

In the isle of Java, and particularly at Bantam, they use the gantan, which amounts to near 3 Dutch pounds. In Golconda, at Visapour, and Goa, they have the furatelle, containing 1 pound 14 ounces English; the mangalis, or mangelin, for weighing diamonds and precious stones, weighing at Goa 5 grains, at Golconda, &c. $5\frac{1}{2}$ grains. They have also the rotolo, containing $14\frac{1}{4}$ ounces English; the metricol, containing the sixth part of an ounce; the wall for piastres and ducats, containing the 73d part of a rial.

In Persia they use two kinds of batmans or mans; the one called *cahi* or *cheray*, which is the king's weight, and the other *batman of Tauris*. The first weighs 13 pounds 10 ounces English; the second $6\frac{1}{2}$ pounds. Its divisions are the ratel, or a 16th; the derhem, or drachm, which is the 50th; the meschal, which is half the derhem; the dung, which is the sixth part of the meschal, being equivalent to 6 carat grains; and, lastly, the grain which is the fourth part of the dung. They have also the vakie, which exceeds a little our ounce; the sah-cheray, equal to the 1170th part of the derhem; and the toman, used to weigh out large payments of money without telling; its weight is that of 50 abasses.

11. *Weights at Cairo in Egypt.*—Almost every kind of goods has its own weight; these are regulated by the cantaren or principal weight.

	Rotels.
The ordinary cantaren, or hundred weight, weighs	100
The cantaren of quicksilver and tin -	102
coffee, wine, and iron -	105
ivory - - - - -	100
almonds and other fruits -	115
woods for dyeing - -	120
arsenic and other drugs -	125
minium and cinnabar -	130
gum arabic, aloes, and other aromatics - -	133

The ratel or rotoli is nearly equal to the pound of Marseilles; 108 lbs. of Marseilles are equal to 110 rotels. The Marseilles pound consists of 13 ounces of Paris; so that the 100 lbs. of Marseilles are equal to 81 lbs. Paris, and 100 lbs. Paris = 123 lbs. of Marseilles.

We shall subjoin here Mr Ferguson's table for comparing the English avoirdupois pound with foreign pounds:

London pound	1.0000	Bruges	1.0204
Antwerp	1.04	Calabria	0.73
Amsterdam	1.1111	Calais	0.9345
Abeville	1.0989	Dieppe	1.0989
Ancona	0.78	Dantzic	0.862
Avignon	0.8928	Ferrara	0.75
Bourdeaux	1.0989	Flanders	0.9433
Bologna	0.8	Geneva	1.07

Ferguson's Tables and Tracts.

Genoa

Weight.

Genoa, gross	0.7	Rochelle	0.8928
Hamburgh	1.0865	Rome	0.7874
Lisbon	1.135	Rouen	1.1089
Leghorn	0.75	Seville	0.9259
Norimberg	1.1363	Thoulouse	0.8928
Naples	0.71	Turin	0.82
Paris	1.1235	Venice	1.06
Prague	1.2048	Vienna	1.23
Placentia	0.72		

In order to show the proportion of the several weights used throughout Europe, we shall add a reduction of them to one standard, viz. the London pound.

The 100 lb. of England, Scotland, and Ireland are equal to

lb.	oz.	
91	8	of Amsterdam, Paris, &c.
96	8	of Antwerp or Brabant.
88	0	of Rouen, the viscounty weight.
106	0	of Lyons, the city weight.
90	9	of Rochelle.
107	11	of Thoulouse and Upper Languedoc.
113	0	of Marseilles or Provence.
81	7	of Geneva.
93	5	of Hamburgh.
89	7	of Francfort, &c.
96	1	of Leipsic, &c.
137	4	of Genoa.
132	11	of Leghorn.
153	11	of Milan.
152	0	of Venice.
154	10	of Naples.
97	0	of Seville, Cadiz, &c.
104	13	of Portugal.
96	5	of Liege.
112	$\frac{2}{3}$	of Russia.
107	$\frac{1}{11}$	of Sweden.
89	$\frac{1}{2}$	of Denmark.

A curious weighing machine was some time ago invented by M. Hanin of Paris, whereby the weights of the principal countries in Europe, and the relative proportions they bear to each other, are shown at one view. For this he received a bounty of 20 guineas from the Society instituted at London for the Encouragement of Arts, Manufactures, and Commerce. The following is a description of this ingenious machine.

Plate DLXXVII fig. 1. Figure 1. represents the back of the machine, which being suspended by the ring A, and a weight hung to the hook B, the spring C, C, C, made fast by strong screws at *g*, is drawn downwards; and the bar D having a rack thereon at *c*, turns the pinion *f*, in proportion to the weight of the body hanging thereto. Fig. 2. Figure 2. shows the face of the machine, on which is a number of concentric circles, and the weights of several countries of Europe engraved thereon, as expressed by the words on a line with them. In the centre of this face is a ring fixed to the small plate, turned by the pinion *f*, shown at figure 1. From this ring a hand projects, which, by the turning of the pinion, points to such part of the circle as is marked with the weight hung to the hook B; and thereby shows what weight of any of the countries mentioned, is equal to the pounds troy of London, which are engraved on the outer circle, or to the pounds avoirdupois, which are engraved on the second circle, and so of the rest. A slider moves on the hand, which may be brought to any of the circles at pleasure, in order to point out the relative weight with greater precision.

Many attempts have been made to introduce an uniformity of weights and measures into the commercial world; but hitherto they have all failed. The accomplishment of such an undertaking would be of infinite advantage to mankind, and certainly claims the most serious attention of those who by their situation can alone bring it about. The undertaking is indeed difficult, but surely not impossible. Something of this kind has been attempted and adopted in France; and, as the method is simple, and exceedingly well adapted for calculation, it surely deserves to be imitated. See MEASURE.

WEIGHT of Air. See PNEUMATICS, N° 14–19.

Regulation of WEIGHTS and Measures, is a branch of the king's prerogative. See PREROGATIVE and MEASURE.

As weight and measure are things in their nature arbitrary and uncertain, it is therefore expedient that they be reduced to some fixed rule or standard: which standard it is impossible to fix by any written law or oral proclamation; for no man can, by words only, give another an adequate idea of a foot rule, or a pound weight. It is therefore necessary to have recourse to some visible, palpable, material standard; by forming a comparison with which all weights and measures may be reduced to one uniform size; and the prerogative of fixing this standard, our ancient law vested in the crown, as in Normandy it belonged to the duke. This standard was originally kept at Winchester: and we find in the laws of King Edgar, near a century before the Conquest, an injunction that the one measure, which was kept at Winchester, should be observed throughout the realm. Most nations have regulated the standard of measures of length by comparison with the parts of the human body; as the palm, the hand, the span, the foot, the cubit, the ell (*ulna* or arm), the pace, and the fathom. But as these are of different dimensions in men of different proportions, our ancient historians inform us, that a new standard of longitudinal measure was ascertained by King Henry the First; who commanded that the *ulna*, or ancient ell, which answers to the modern yard, should be made of the exact length of his own arm. And one standard of measure of length being gained, all others are easily derived from thence; those of greater length by multiplying, those of less by dividing, that original standard. Thus, by the statute called *compositio ulnarum et perticarum*, five yards and a half make a perch; and the yard is subdivided into three feet, and each foot into 12 inches; which inches will be each of the length of three grains of barley. Superficial measures are derived by squaring those of length; and measures of capacity by cubing them. The standard of weights was originally taken from corns of wheat; whence the lowest denomination of weights we have is still called a *grain*; 32 of which are directed, by the statute called *compositio mensurarum*, to compose a pennyweight, whereof 20 make an ounce, 12 ounces a pound, and so upwards. And upon these principles the first standards were made; which, being originally so fixed by the crown, their subsequent regulations have been generally made by the king in parliament. Thus, under King Richard I. in his parliament holden at Westminster, A. D. 1197, it was ordained that there should be only one weight and one measure

measure throughout the kingdom, and that the custody of the assize, or standard of weights and measures, should be committed to certain persons in every city and borough; from whence the ancient office of the king's aulnager seems to have been derived, whose duty it was, for a certain fee, to measure all cloths made for sale, till the office was abolished by the statute 11th and 12th William III. c. 20. In King John's time this ordinance of King Richard was frequently dispensed with for money; which occasioned a provision to be made for enforcing it, in the great charters of King John and his son. These original standards were called *pondus regis* and *mensura domini regis*, and are directed by a variety of subsequent statutes to be kept in the exchequer chamber, by an officer called the *clerk of the market*, except the wine gallon, which is committed to the city of of London, and kept in Guildhall.

The *Scottish* standards are distributed among the oldest boroughs. The elwand is kept at Edinburgh, the pint at Stirling, the pound at Lanark, and the firlot at Linlithgow.

Various statutes have been enacted for regulating and enforcing an uniformity of weights and measures; and by the articles of union, the English standards are established by law over all Great Britain. But the force of custom is so strong, that these statutes have been ill observed. The Scottish standards are still universally retained for many purposes; and likewise a variety of local weights and measures are used in particular places of both countries, which differ from the general standards of either. A report was made by a committee of the House of Commons on the subject of weights and measures, 24th June, 1819, recommending alterations of a very limited nature; but nothing farther has been done.

WEINMANNIA, a genus of plants of the class *octandria*, order *monogynia*, and arranged in the natural classification with those plants the order of which is doubtful.

WELD, or WOLD. See RESEDA, BOTANY *Index*, and DYEING.

WELDING HEAT, in smithery, a degree of heat given to iron, &c. sufficient to make the surfaces of two pieces incorporate upon being beaten together with a hammer.

WELL, a hole under ground, usually of a cylindrical figure, and walled with stone and mortar: its use is to collect the water of the strata around it.

WELL, an apartment formed in the middle of a ship's hold to inclose the pumps, from the bottom to the lower decks. It is used as a barrier to preserve those machines from being damaged by the friction or compression of the materials contained in the hold, and particularly to prevent the entrance of ballast, &c. by which the tubes would presently be choked, and the pumps rendered incapable of service. By means of this inclosure, the artificers may likewise more readily descend into the hold, in order to examine the state of the pumps, and repair them as occasion requires.

WELL-Room of a Boat, the place in the bottom where the water lies between the ceiling and the platform of the stern-sheets, whence it is thrown out into the sea with a scoop.

Burning-WELL. See *BURNING-Spring*.

WELL of a Fishing-vessel, an apartment in the middle of the hold, which is entirely detached from the rest, being lined with lead on every side, and having the bottom thereof penetrated with a competent number of small holes passing also through the ship's floor; so that the salt-water running into the well is always kept as fresh as that in the sea, and yet prevented from communicating itself to the other parts of the hold.

WELL-hole, in building, is the hole left in a floor for the stairs to come up through.

WELLS, a city of Somersetshire, and see of a bishop; the bishop of Bath being also that of Wells.—It is supposed to take its name from the many springs and wells that are near it. It is not very large; but is adorned with handsome buildings, and contained 5156 inhabitants in 1811. Its cathedral is a very beautiful structure, adorned with images and carved stone work. The bishop's palace joins to the cathedral; and on the other side are the houses for the prebendaries. In the market-place is a fine market house, supported by pillars. It is governed by a mayor, and sends two members to parliament. The chief manufacture is knit hose. W. Long. 2. 40. N. Lat. 51. 12.

WEN, a tumor or excrescence arising on different parts of the body, and containing a cystus or bag filled with some peculiar kind of matter. See NÆVUS, SURGERY *Index*.

WEREGILD, the price of *homicide;* paid partly to the king for the loss of a subject, partly to the lord whose vassal he was, and partly to the next of kin of the person slain.

WERST, WURST, or *Verst*, a Russian measure equal to 3500 English feet. A degree of a great circle of the earth contains about 104 wersts and a half.

WERTURIAN or *URALIAN Mountains*, a famous chain of mountains forming part of the boundary of Asia. It begins distinctly (for it may be traced interruptedly farther south) near the town of Kungur, in the government of Kasan, in latitude 57° 20'; runs north, and ends opposite to the Waygatz strait, and rises again in the isle of *Nova Zemlja*. The Russians also call this range *Semennoi Poias*, or, *the girdle of the world;* from a supposition that it encircled the universe. These were the *Riphæi montes: Pars mundi damnata a natura rerum, et densa mersa caligine* *; of which only the southern part was known to the ancients, and that so little as to give rise to numberless fables. Beyond these were placed the happy *Hyperborei*, a fiction most beautifully related by Pomponius Mela. Moderns have not been behind-hand in exaggerating several circumstances relative to these noted hills. Ysbrand Ides, who crossed them in his embassy to China, asserts that they are 5000 toises or fathoms high; others, that they are covered with eternal snow. The last may be true in their more northern parts; but in the usual passages over them, they are free from it three or four months.

* *Plinii Hist. Nat.* lib. iv. cap. 12.

The heights of part of this chain have been taken by M. l'Abbé d'Auteroche: who, with many assurances of his accuracy, says, that the height of the mountain Kyria near Solikamskaia, in latitude 60°, does not exceed 471 toises from the level of the sea, or 286 from the ground on which it stands. But according to M. Gmelin, the mountain Pauda is much higher, being 752 toises above the sea. From Petersburgh to this chain is a vast plain, mixed with certain elevations or platforms, like islands in the midst of an ocean. The eastern side descends gradually to a great distance into the wooded and morassy Siberia, which forms an im-

Werturian, Wesley.

mense inclined plane to the Icy sea. This is evident from all the great rivers taking their rise on that side, some at the amazing distance of latitude 46°; and, after a course of about 27 degrees, falling into the Frozen ocean, in latitude 73° 30′. The Yaik alone, which rises near the southern part of the eastern side, takes a southern direction, and drops into the Caspian sea. The Dwina, the Peczora, and a few other rivers in European Russia, shew the inclined plane of that part. All of them run to the northern sea; but their course is comparatively short. Another inclination directs the Dnieper and the Don into the Euxine, and the vast Wolga into the Caspian sea.

WESLEY, John, a very extraordinary character, and founder of the sect of Methodists, was the son of the Reverend Samuel Wesley, rector of Epworth in the isle of Axholme in Lincolnshire, and was born in that village in the year 1703. His very infancy was distinguished by an extraordinary incident; for when he was only six years old, the parsonage-house at Epworth was burnt to the ground, and the flames had spread with such rapidity, that few things of value could be saved. His mother, in a letter to her son Samuel Wesley, then on the foundation at Westminster school, thanks God that no lives were lost, although for some time they gave up *Poor Jacky*, as she expresses herself; for his father had twice attempted to rescue the child, but was beaten back by the flames. Finding all his efforts ineffectual, he resigned him to Divine Providence. But parental tenderness prevailed over human fears, and Mr Wesley once more attempted to save his child. By some means equally unexpected and unaccountable, the boy got round to a window in the front of the house, and was taken out, by one man's leaping on the shoulders of another, and thus getting within his reach. Immediately on his rescue from this very perilous situation, the roof fell in. This extraordinary escape explains a certain device, in a print of Mr John Wesley, engraved by Vertue, in the year 1745, from a painting by Williams. It represents a house in flames, with this motto from the prophet, "Is he not a brand plucked out of the burning?" Many have supposed this device to be merely emblematical of his spiritual deliverance; but from this circumstance it is apparent that it has a primary as well as a secondary meaning; it is real as well as allusive.

In the year 1713 he was entered a scholar at the Charter-house in London, where he continued seven years under the tuition of the celebrated Dr Walker, and of the Rev. Andrew Tooke author of The Pantheon. Being elected to Lincoln college, Oxford, he became a fellow of that college about the year 1725, took the degree of Master of Arts in 1726, and was joint tutor with the Rev. Dr Hutchins the rector. He discovered very early an elegant turn for poetry. Some of his gayer poetical effusions are proofs of a lively fancy and a fine classical taste; and some translations from the Latin poets, while at college, are allowed to have great merit. He had early a strong impression, like Count Zinzendorff, of his designation to some extraordinary work. This impression received additional force from some domestic incidents; all which his active fancy turned to his own account. His wonderful preservation, already noticed, naturally tended to cherish the idea of his being designed by Providence to accomplish some purpose or other, that was out of the ordinary course of human events. The late Rev. Samuel Badcock, in a letter inserted in the Bibliotheca Topographica Britannica, N° XX. says, "There were some strange phenomena perceived at the parsonage at Epworth, and some uncommon noises heard there from time to time, which he was very curious in examining into, and very particular in relating. I have little doubt that he considered himself the chief object of this wonderful visitation. Indeed his father's credulity was in some degree affected by it; since he collected all the evidences that tended to confirm the story, arranged them with scrupulous exactness, in a manuscript consisting of several sheets, and which is still in being. I know not what became of the ghost of Epworth; unless, considered as the prelude to the noise Mr John Wesley made on a more ample stage, it ceased to speak when he began to act."

"The dawn of Mr Wesley's public mission (continues Mr Badcock) was clouded with mysticism; that species of it which affects silence and solitude; a certain inexplicable introversion of the mind, which abstracts the passions from all sensible objects; and as the French Quietists express it, perfects itself by an absorption of the will and intellect, and all the faculties, into the Deity." In this *palpable obscure* the excellent Fenelon led himself, when he forsook the shades of Pindus, to wander in quest of *pure love* with Madam Guyon! Mr Wesley pursued for a while the same *ignis fatuus* with Mr William Law and the Ghost of De Renty. A state, however, so torpid and ignoble, ill suited the active genius of this singular man. His elastic mind gained strength by compression; thence bursting glorious, he passed (as he himself somewhere says) "the immense chasm, upborne on an eagle's wings."

The reading of the writings of this Mr William Law, the celebrated author of Christian Perfection, and of A Serious Address to the Christian World, contributed moreover, to lead Mr John Wesley and his brother Charles with a few of their young fellow-students, into a more than common strictness of religious life. They received the sacrament of the Lord's Supper every week; observed all the fasts of the church; visited the prisons; rose at four in the morning; and refrained from all amusements. From the exact method in which they disposed of every hour, they acquired the appellation of *Methodists;* by which their followers have been ever since distinguished.

But a more particular account of the origin of this sect, we shall give from a celebrated publication. "The Methodists (says the editor of this work) form a very considerable class, principally of the lower people in this country. They sprung up about fifty years ago at Oxford, and were soon divided into two parties; the one under the direction of Mr George Whitefield, and the other under that of two brothers, John and Charles Wesley. These leaders, and, if we except Mr William Law, founders of the Methodists, were educated at Oxford, received episcopal ordination, and always professed themselves advocates for the articles and liturgy of the established church; though they more commonly practised the dissenting mode of worship. But conceiving a design of forming separate communities, superior in sanctity and perfection to all other Christian churches, and impressed to a very considerable degree by a zeal of an extravagant and enthusiastic kind, they became itinerant preachers; and, being excluded from most of our churches, exercised their ministry in private houses,

fields

Wesley.

fields, &c. not only in Great Britain and Ireland, but also in America; thus collecting a very considerable number of hearers and proselytes, both among the members of the established church and the dissenters. The theological system of Mr Whitefield and his followers is Calvinistic; that of Mr Wesley and his disciples Arminian; and the latter maintains the possibility of attaining sinless perfection in the present state. The subordinate teachers of both these classes of Methodists are generally men of no liberal education; and they pretend to derive their ministerial abilities from special communications of the Spirit. The Methodists of both parties, like other enthusiasts, make true religion to consist principally in certain affections and inward feelings which it is impossible to explain; but which, when analysed, seem to be mechanical in their spring and operation; and they generally maintain, that Christians will be most likely to succeed in the pursuit of truth, not by the dictates of reason, or the aids of learning, but by laying their minds open to the direction and influence of divine illumination; and their conduct has been directed by impulses."

Our readers will judge for themselves, according to their various modes of education, and to the different lights in which they may respectively view the doctrines of our common Christianity, whether this representation of the origin of the Methodists, and of their distinguishing tenets, be accurate and just.—Not presuming to sit in judgment on the religious opinions of any man, we shall only observe, that an appellation originally given in reproach, has been gloried in ever since by those who have distinguished themselves as the followers either of Mr Whitefield or of Mr Wesley. "After the way called *Methodists*, so worship they the God of their fathers." But the ridicule and contempt which the singularity of their conduct produced, both John and Charles Wesley were well qualified to bear. They were not to be intimidated by danger, actuated by interest, or deterred by disgrace.

The boundaries of this island were soon deemed by Mr Wesley too confined for a zeal which displayed the piety of an apostle, and of an intrepidity to which few missionaries had been superior. In 1735 he embarked for Georgia, one of our colonies, which was at that time in a state of political infancy; and the great object of this voyage was to preach the gospel to the Indian nations in the vicinity of that province. He returned to England in 1737. Of his spiritual labours, both in this country and in America, he himself has given a very copious account, in a series of Journals printed at different periods. These journals drew upon our laborious preacher and his coadjutors some severe animadversions from two right reverend prelates; Dr George Lavington bishop of Exeter, and Dr William Warburton bishop of Gloucester. The former published, in three parts, The Enthusiasm of the Methodists and Papists compared; the third part of this performance containing a personal charge of immoral conduct. Mr Wesley, in his vindication, published a letter to his lordship, which produced a reply from the latter.

Bishop Warburton's attack is contained in his celebrated treatise, entitled The Doctrine of Grace: or, The Office and Operations of the Holy Spirit vindicated from the Insults of Infidelity, and the Abuses of Fanaticism: concluding with some thoughts, humbly offered to the consideration of the Established Clergy, with regard to the Right Method of defending Religion against the Attacks of either party; 2 vols. small 8vo, 1762. There is much acute reasoning, and much poignant and sprightly wit, in his Doctrine of Grace; but there is too much levity in it for a grave bishop, and too much abuse for a candid Christian. On this occasion, Mr Wesley published a letter to the bishop, in which, with great temper and moderation, as well as with great ingenuity and address, he endeavoured to shelter himself from his lordship's attacks; not only under the authority of the Holy Scriptures, but of the church itself, as by law established.

On his return from Georgia, Mr Wesley paid a visit to Count Zinzendorf, the celebrated founder of the sect of Moravians, or Hernhutters, at Hernhut in Upper Lusatia. In the following year he appeared again in England, and with his brother Charles, at the head of the Methodists. He preached his first field-sermon at Bristol, on the 2d of April 1738, from which time his disciples have continued to increase. In 1741, a serious altercation took place between him and Mr Whitefield. In 1744, attempting to preach at an inn at Taunton, he was regularly silenced by the magistrates. Although he chiefly resided for the remainder of his life in the metropolis, he occasionally travelled through every part of Great Britain and Ireland, establishing congregations in each kingdom. In 1750 he married a lady, from whom he was afterwards separated. By this lady, who died in 1781, he had no children.

We have already mentioned Mr Wesley as a very various and voluminous writer. Divinity, both devotional and controversial, biography, history, philosophy, politics, and poetry, were all, at different times, the subjects of his pen: and, whatever opinion may be entertained of his theological sentiments, it is impossible to deny him the merit of having done very extensive good among the lower classes of people. He certainly possessed great abilities, and a fluency which was well accommodated to his hearers, and highly acceptable to them. He had been gradually declining for three years before his death; yet he still rose at four in the morning, and preached, and travelled, and wrote as usual. He preached at Leatherhead in Surrey, on the Wednesday before that event. On the Friday following, appeared the first symptoms of his approaching dissolution. The four succeeding days he spent in praising God; and he left this scene, in which his labours had been so extensive and so useful, at a quarter before ten in the morning of the 2d of March 1791, in the 88th year of his age. His remains, after lying in a kind of state at his chapel in the city-road, dressed in the sacerdotal robes which he usually wore, and on his head the old clerical cap, a bible in one hand, and a white handkerchief in the other, were, agreeably to his own directions, and after the manner of the interment of the late Mr Whitefield, deposited in the cemetry behind his chapel, on the morning of the 9th March, amid an innumerable concourse of his friends and admirers; many of whom appeared in deep mourning on the occasion. One singularity was observable in the funeral service. Instead of, "We give thee hearty thanks, for that it hath pleased thee to deliver this our brother;" it was read "our father." A sermon, previously to the funeral, had been preached by Dr Thomas Whitehead, one of the physicians to the

London

Wesley, West.

London hospital; and on the 13th the different chapels of his persuasion in London were hung with black.

It has been justly observed of Mr Wesley, that his labours were principally devoted to those who had no instructor; to the highways and hedges; to the miners in Cornwall, and the coalliers in Kingswood. These unhappy creatures married and buried among themselves, and often committed murders with impunity, before the Methodists sprung up. By the humane and active endeavours of Mr Wesley and his brother Charles, a sense of decency, morals, and religion, was introduced into the lowest classes of mankind; the ignorant were instructed, the wretched relieved, and the abandoned reclaimed. His personal influence was greater, perhaps, than that of any other private gentleman in any country.—But the limits of this article will not permit us to expatiate further on the character of this extraordinary man.

WEST, GILBERT, was the son of Dr West, prebendary of Winchester, and chaplain to King George I. but at 12 years of age lost his father. He studied at Winchester and Eton schools, and from thence was placed in Christ-church college, Oxford. His studious and serious turn inclined him to take orders; but Lord Cobham, his uncle, diverted him from that pursuit, and gave him a cornetcy in his own regiment. This profession he soon quitted, on account of an opening of another nature, which presented him with a flattering prospect of advancement in life. A number of young gentlemen were to be elected from the universities, and, at the expence of government, were to be taught foreign languages; and then sent to the secretaries office, to be initiated into business, and trained there for public services, as envoys, ambassadors, &c. Mr Gilbert West was one of the few pitched upon; and on his first introduction into that office, Lord Townsend, secretary of state, treated him with singular marks of regard, and the strongest inclinations to serve him were testified from all quarters. But his uncle Lord Cobham's strong opposition to the measures of the government, rendered these advantages entirely fruitless; and the ministers honestly told Mr West, that he must not expect them to distinguish his merit, as any favours conferred upon him would be imputed as done to his uncle Lord Cobham. Mr West now left that office, and all his views of making his fortune; and entering into marriage, retired to Wickham in Kent, where he lived in great domestic comfort and tranquil happiness. He was there visited by his valuable friends, who held the most delightful converse of wit, humour, and learning, supported upon the principles of virtue, sound reasoning, and solid friendship, which rendered the whole cheerful, animating, and instructive. Mr William Pitt, who was one of those that composed this happy society, becoming paymaster, appointed Mr West treasurer to Chelsea-hospital; and he obtained a seat at the council board, in consequence of a friendship contracted at the school with one of the duke of Devonshire's sons, who procured of his grace his being nominated one of the clerks extraordinary of that office. Towards the latter part of Mr West's life, he wholly applied himself to the study of the Scriptures; being extremely anxious to try his utmost endeavours to reconcile the seeming inconsistencies which gave the enemies to revealed religion a handle to doubt and discredit their authenticity. His observations on the resurrection, which, it has been said, were written to confirm the wavering faith of his great friends Pitt and Lyttleton, bear ample testimony to his reasoning powers and the sincerity of his religion; while his translations of Pindar show him to have been an eminent Greek scholar, and very considerable poet. He had a mind replete with virtue, and was an honour to his country; but died at 50 years of age.

WEST, one of the cardinal points of the horizon, diametrically opposite to the east; and strictly defined the intersection of the prime vertical with the horizon on that side the sun sets in.

WESTMINSTER, a city which forms the west part of the capital of Britain, but has a government distinct from the rest. This city had its name from the situation of its abbey, anciently called a *minster*, in respect of that of St Paul. That part properly called the city of Westminster, comprehending the parishes of St John and St Margaret, was once an island formed by the Thames, called *Thorney island*, from the thorns with which it was overrun; and the abbey that stood in it, Thorney abbey. The liberties of Westminster contain the several parishes of St Martin in the Fields, St James's, St Anne, St Paul, Covent-Garden, St Mary le Strand, St Clement Danes, St George, Hanover Square, and the precinct of the Savoy. The government, both of the city and liberties, is under the jurisdiction of the dean and chapter of Westminster, in civil as well as ecclesiastical affairs; and their authority extends to the precinct of St Martin le Grand, by Newgate-street, and in some towns of Essex, which are exempted from the jurisdiction of the bishop of London and the archbishop of Canterbury; but the management of the civil part has, ever since the Reformation, been in the hands of laymen, elected from time to time, and confirmed by the dean and chapter. The chief of these laymen are the high-steward, the deputy-steward, and the high-bailiff, who hold their offices for life. There are also 16 burgesses and their assistants, out of which are elected two head-burgesses, one for the city, and the other for the liberties. Another officer is the high-constable, who has all the other constables under his direction.

WESTMORELAND, a county of England, bounded on the north and north-west by Cumberland; on the south and south-east by Yorkshire; and on the south and south-west by Lancashire. Its extent from north-east to south, is 40 miles, and its breadth from the east projection to that in the west, 42. It is generally divided into the baronies of Kendal and Westmoreland: the former is very mountainous, but the latter is a large champaign country. These are the only principal divisions of this county, which contains eight market-towns, 26 parishes, and in 1811 the number of inhabitants was 45,922. It lies partly in the diocese of Chester, and partly in that of Carlisle. The earl of Thanet is hereditary sheriff of the county, which sends only four members to parliament. The air is clear, sharp, and salubrious, the natives being seldom troubled with diseases, and generally living to old age. The soil is various; that on the mountains is very barren, while that in the valleys is fertile, producing good corn and grass, especially in the meadows near the rivers. In the hilly parts on the western borders it is generally believed there are vast quantities of copper ore, and veins of gold; some mines of copper are worked, but most of the ore lies so deep that it it will not answer the expence. This county yields the finest slate, and abundance of excellent hams are cured here. The principal rivers are, the Eden, the Lone, and the Ken. It has also several fine lakes, the principal of which is Windermere. In the forest of Martindale, to the south of Ulls-water, the breed of red deer still exists in a wild state.—Appleby is the county town. See WESTMORELAND, SUPPLEMENT.

WESTPHALIA, formerly a duchy of Germany, bounded to the east by the bishopric of Paderborn, and the territories of Waldeck and Hesse; to the south by the counties of Witgenstein and Nassau, and the duchy of Berg; to the north by the bishopric of Munster and the county of Lippe. It is about 40 miles in length and 30 in breadth. The lower part of it is very fruitful, yielding plenty of corn and cattle, and some salt springs. The higher affords iron ore, calamine, lead, copper, some silver and gold, fine woods, cattle, game, fish, with a little corn. The rivers, that either pass through the duchy or along its borders, are the Rahr, the Lenne, the Bigge, the Dimel, and the Lippe. There are 28 towns in it, besides boroughs and cloisters. The provincial diets were held at Arensberg. In the year 1180, the emperor Frederic I. made a donation of this duchy to the archbishopric of Cologne, which was confirmed by succeeding emperors; and in 1638, the last duke of Arensberg ceded to it also the county of Arensberg.

WESTPHALIA, one of the circles of Germany. Anciently the people inhabiting between the Weser and the Rhine, were called *Westphalians;* and hence that tract got the name of *Westphalia:* but the circle of that name is of a larger extent, being surrounded by the circle of Burgundy, or the Austrian Netherlands, the United Provinces, and the North sea, with the circles of the Upper and Lower Rhine, and comprising a great many different states.

With respect to religion, Westphalia is partly Protestant and partly Catholic; but the Protestants predominate, and are, at least the greater part of them, Calvinists. The air of this country is not reckoned very wholesome, and towards the north is extremely cold in winter. The soil in general is marshy and barren; yet there is some good corn and pasture land; but the fruit is chiefly used to feed hogs; and hence it is that their bacon and hams are so much valued and admired.

After the peace of Tilsit in 1807, the principalities of Hanover, Brunswick, Magdeburg, Old Mark, Hesse Cassel, with some other territories, were erected into the kingdom of Westphalia, which was governed by Jerome Bonaparte. This state disappeared on the overthrow of the French power in 1814, and the territories which composed it were restored to their former princes. Jerome Bonaparte's court was kept at Cassel, the capital of the principality of Hesse.

WESTRINGIA, a genus of plants, formed from *cunila fruticosa*, which was discovered by Dr Solander in New Holland. Dr Smith describes it as approaching nearer to rosemary, and places it after *teucrium* in the class didynamia.

WET-COUCH, *Coming-heap*, a term used by the maltsters for one of the principal articles of malt-making. See BREWING, N° 4.

WETSTEIN, JOHN JAMES, a learned German divine, was born at Basil in 1693. On his admission to the ministry, he maintained a thesis *De variis Novi Testamenti Lectionibus;* in which he showed that the great variety of readings of the New Testament afford no argument against the authenticity of the text. He had made these various readings the object of his attention; and travelled into foreign countries to examine all the MSS. he could come at. In 1730, he published *Prolegomena ad Novi Testamenti Græci editionem accuratissimam*, &c. Some divines, dreading his unsettling the present text, procured a decree of the senate of Basil against his undertaking, and even got him prohibited from officiating in the ministry; on which he went to Amsterdam, where the Remonstrants named him to succeed the famous Le Clerc, then superannuated, as professor of philosophy and history. At last he published his edition of the New Testament, in 2 vols. folio, 1752; in which he left the text as he found it, placing the various readings, with a critical commentary, underneath; subjoining two epistles of Clemens Romanus, till then unknown to the learned, but discovered by him in a Syriac MS. of the New Testament. He also published some small works; and is said to have been not only an universal scholar, but to have abounded in good and amiable qualities. He died at Amsterdam in 1754.

WETTERAVIA, the southern division of the landgravate of Hesse in Germany, lying along the northern bank of the river Maine, and comprehending the counties of Hanau and Nassau.

WEXFORD, a county of Ireland, in the province of Munster, 38 miles in length, and 24 in breadth; bounded on the north by Wicklow, on the east by St George's channel, on the south by the Atlantic ocean, on the west by Waterford and Kilkenny, and on the north by Catherlough. It contains 109 parishes, and formerly sent 18 members to the Irish parliament. It is a fruitful country in corn and grass. See WEXFORD, SUPPLEMENT.

WEXFORD, a sea-port of Ireland, capital of a county of the same name. It was once reckoned the chief city in Ireland, being the first colony of the English, and is still a large handsome town, with a very commodious harbour at the mouth of the river Slana, on a bay of St George's channel, 63 miles south of Dublin. W. Long. 6. 25. N. Lat. 52. 18.

WHALE. See BALÆNA and PHYSETER, CETOLOGY *Index*.

WHALE, one of the constellations. See ASTRONOMY.

WHALE-Bone. For its natural history, see CETOLOGY *Index*.

A patent was granted in October 1806 to Robert Bowman of Leith, in Scotland, for making hats, caps, and bonnets for men and women, of whalebone; harps for harping or cleansing corn or grain; and also the bottoms of sieves and riddles, and girths for horses; and also a cloth or webbing for making into hats, caps, &c.; and for the backs and seats of chairs and sofas, gigs, coaches, and other similar carriages; and the bottoms of beds; as also reeds for weavers.

WHALE-Fishery. See CETOLOGY.

WHARF, a space on the banks of a haven, creek, or hithe, provided for the convenient loading and unloading of vessels.

WHARTON, PHILIP DUKE OF, a nobleman of the most brilliant parts, but of the most whimsical, extravagant, and inconsistent turn of mind, was educated by his father's

Wharton.

father's express order at home. He very early married a young lady, the daughter of Major-General Holmes, which disappointed his father's views of disposing of him in such a marriage as would have been a considerable addition to the fortune and grandeur of his illustrious family; yet that amiable lady deserved infinitely more felicity than she met with by this alliance. This precipitate marriage is thought to have hastened the death of his father; after which the duke, being free from paternal restraints, plunged into those excesses which rendered him, as Pope expresses it,

> " A tyrant to the wife his heart approv'd;
> " A rebel to the very king he lov'd."

In the beginning of the year 1716, he began his travels; and as he was designed to be instructed in the strictest Whig principles, Geneva was thought a proper place for his residence. He first passed through Holland, and visited several courts of Germany; and being arrived at Geneva, conceived such a disgust against his governor, that he left him, and set out post for Lyons, where he wrote a letter to the chevalier de St George, who then resided at Avignon, and presented him a very fine stout horse; which the chevalier no sooner received than he sent a man of quality to him, who took him privately to his court, where he was entertained with the greatest marks of esteem, and had the title of duke of Northumberland conferred upon him. He, however, remained there but one day, and then returned post to Lyons, whence he set out for Paris. He likewise paid a visit to the consort of James II. who then resided at St Germains, to whom he also paid his court. During his stay at Paris, his winning address and abilities gained him the esteem and admiration of all the British subjects of rank of both parties.

About the latter end of December 1716, he arrived in England, whence he soon after set out for Ireland, where, though under age, he was allowed the honour to take his seat in the house of peers, and immediately distinguished himself, notwithstanding his former conduct, as a violent partizan for the ministry; in consequence of which zeal the king created him a duke. He no sooner came of age than he was introduced to the house of lords in England with the same blaze of reputation. In a little time he opposed the court, and appeared one of the most vigorous in defence of the bishop of Rochester; and soon after printed his thoughts twice a-week, in a paper called the *True Briton*, several thousands of which were circulated.

The duke's boundless profusion had by this time so burdened his estate, that by a decree of Chancery it was vested in the hands of trustees for the payment of his debts, allowing him a provision of 1200l. per annum for his subsistence. This being insufficient to support his title with suitable dignity, he went abroad, and shone to great advantage, with respect to his personal character, at the imperial court. From thence he made a tour to Spain: the English minister was alarmed at his arrival, fearing that his grace was received in the character of an ambassador: upon which the duke received a summons under the privy seal to return home; but instead of obeying it, he endeavoured to inflame the Spanish court against that of Great Britain, for exercising an act of power, as he calls it, within the jurisdiction of his Catholic majesty. He then acted openly in the service of the Pretender, and was received at his court with the greatest marks of favour.

While his grace was thus employed, his neglected duchess died in England on the 14th of April 1726, without issue. Soon after the duke fell violently in love with M. Oberne, one of the maids of honour to the queen of Spain, the daughter of an Irish colonel, whose fortune chiefly consisted in her personal accomplishments. All his friends, and particularly the queen of Spain, opposed the match; but he falling into a lingering fever, occasioned by his disappointment, the queen gave her consent, and they were soon after married. He then spent some time at Rome, where he accepted of a blue garter, assumed the title of duke of Northumberland, and for a while enjoyed the confidence of the exiled prince. But not always keeping within the bounds of Italian gravity, it became necessary for him to remove from hence; when, going by sea to Barcelona, he wrote a letter to the king of Spain, acquainting him that he would assist at the siege of Gibraltar as a volunteer. Soon after he wrote to the chevalier de St George, expressing a desire to visit his court; but the chevalier advised him to draw near to England.

The duke seemed resolved to follow his advice; and setting out with his duchess, arrived in Paris in May 1728, whence he soon after proceeded to Rouen, where he took up his residence; and was so far from making any concession to the government of England, that he did not give himself the least trouble about his estate, or any other concern there, though, on his arrival at Rouen, he had only about 600l. in his possession, and a bill of indictment was preferred against him in England for high-treason. Soon after the chevalier sent him 2000l. which he squandered away in a course of extravagance; when, to save the charges of travelling by land, he went from Orleans to Nantz by water, and staid there till he got a remittance from Paris, which was squandered almost as soon as received. At Nantz he was joined by his ragged servants, and from hence took shipping with them for Bilboa, when the queen of Spain took the duchess to attend her person. About the beginning of the year 1731, the duke, who commanded a regiment, was at Lerida, but declined so fast that he could not move without assistance; yet when free from pain did not lose his gaiety. He, however, received benefit from some mineral waters in Catalonia; but soon after relapsed at a small village, where he was utterly destitute of all the necessaries of life, till some charitable fathers of a Bernardine convent removed him to their house, and gave him all the relief in their power. Under their hospitable roof he languished a week, and then died, without one friend or acquaintance to close his eyes; and his funeral was performed in the same manner in which the fathers inter those of their own fraternity.

Thus died Philip duke of Wharton, " who, like Buckingham and Rochester (says Mr Walpole), comforted all the grave and dull, by throwing away the brightest profusion of parts on witty fooleries, debaucheries, and scrapes, which mix graces with a great character, but never can compose one.

" With attachment to no party, though with talents to govern any party, this lively man changed the free air of Westminster for the gloom of the Escorial, the prospect of King George's garter for the Pretender's; and

Wharton, Wheat.

and with indifference to all religion, the frolic lord who had written the ballad on the archbishop of Canterbury, died in the habit of a capuchin. It is difficult to give an account of the works of a man whose library was a tavern, and women of pleasure his muses. A thousand sallies of his imagination may have been lost. There are only two volumes in 8vo, called *his Life and Writings*. These contain nothing of the latter, but 74 numbers of the True Briton, and his speech in defence of the bishop of Rochester. His other works are the ballads above mentioned; the Drinking Match at Eden hall, in imitation of the Chevy Chace, printed in a miscellany called *Whartoniana;* and a parody of a song sung at the opera house by Mrs Tofts. His lordship also began a play on the story of the queen of Scots."

WHEAT. See TRITICUM, BOTANY *Index;* and for the culture of wheat, see AGRICULTURE *Index*.

The three principal kinds of bad wheat are, the *blighted*, the *smutty*, and the *worm-eaten*. Blighted wheat is that of which the stalk is a little twisted and rickety, the blade being of a bluish green and curled up, the grain also is green and tubercled: smutty wheat appears as if great part of the ear had been burnt, some small parts only being free, and, in particular, the stem that rises in the centre of the ear, round which the grain is ranged: worm-eaten or rotten wheat is corrupted without losing much of its natural form, or external appearance; the husk is filled with a greasy black powder, that is insufferably fetid. It appeared, from the experiments of M. Tillet, that there was a kind of infectious quality in all those kinds of wheat: so that if sound wheat was sprinkled with the flower of smutty or rotten wheat, the crop produced would be rotten or smutty. It appeared also, that among the grain which was produced from ground manured with the straw of distempered wheat, there was a much greater proportion of distempered wheat than in that produced from ground manured with the straw of good wheat; the great secret then was to destroy the principle of this contagion in the wheat that was put into the ground; and M. Tillet found, as the result of a great number of experiments, that if the grain, before it is sowed, be well moistened with a solution of sea-salt, or nitre, in common water, none of the ensuing crop will be smutty, or otherwise defective, either in kind or quality; not only supposing the grain that is sowed to be sound, and the soil to be good, but even supposing the grain to be strewed with the flour of smutty wheat, and the ground manured with bad straw.

Prize Dissertation by the Academy of Bourdeaux.

The following receipt for preventing smutty wheat was published in 1769 by order of the Society for the Encouragement of Arts: they received it from Mr John Reynolds of Adisham in Kent.

A tub is to be procured that has a hole at bottom, in which a staff and tap-hose is to be fixed over a whisp of straw, to prevent any small pieces of lime passing (as in the brewing way); this done, we put 70 gallons of water, then a corn bushel heap-full of stone-lime, unslaked, stirring it well till the whole is dissolved or mixed, letting it stand about 30 hours, and then run it off into another tub as clear as we can (as practised in beer): this generally produces a hogshead of good strong lime-water; then add three pecks of salt, 42 pounds, which, with a little stirring, will soon dissolve; thus we have a proper pickle for the purpose of brining and liming our seed-wheat without any manner of obstacle, which is more than can be said in doing it the common way, and greatly facilitates the drilling.

Wheat ‖ Wheel-carriages.

Herein we steep the wheat in a broad-bottomed basket of about 24 inches in diameter, and 20 inches deep (for large sowing, made on purpose), running in the grain gradually in small quantities from 10 to 12 gallons up to 16 gallons, stirring the same. What floats, we skim off with a strainer, and is not to be sown: then draw up the basket to drain over the pickle, for a few minutes; all which may be performed within half an hour, sufficiently pickled; and so proceed as before. This done, the wheat will be fit for sowing in 24 hours, if required; but if designed for drilling, two hours pickled will be found best; and if prepared four or five days before-hand, in either case it makes no difference at all; but should the seed be clammy, and stick to the notches in the drill-box, more lime must be added to the lime-water: here the master must use his discretion, as the case requires; for some lime has much more drying or astringent qualities in it than others. If sea-water can be obtained conveniently, much less salt will suffice, but some will be found necessary even then, otherwise the light grains will not float, a thing of more consequence than is generally imagined, and it ought to be skimmed off and thrown aside for poultry, &c.

WHEEL, in *Mechanics*, a simple machine, consisting of a round piece of wood, metal, or other matter, which revolves on its axis. See MECHANICS.

Wheel-Carriages. See MECHANICS for an account of the general principles.

No kind of wheel-carriages are of more importance to a commercial and manufacturing country than stage coaches; and perhaps in no kingdom of Europe has the system of travelling in public vehicles been carried to greater perfection, as to comfort and speed, than in Britain. The danger, however, of travelling by these coaches makes considerable deduction from their accommodation otherwise: it is but too well known that this mode of travelling is liable to frequent and serious accidents. Every attempt therefore that promises to be useful in diminishing such danger should have all possible publicity. With this view we are much gratified in having an opportunity of laying before our readers the following account of an invention to render stage coaches more secure from danger, obligingly transmitted to us by the inventor, the reverend William Milton of Heckfield, Hants. For this invention that gentleman has obtained a patent.

The danger of stage coaches arises sometimes from *overturning*, and sometimes from *breaking down*. The *overturn* is, in general, occasioned *either* by taking two side-wheels into too deep a hole or ditch, or over too high a bank; *or*, secondly, by running down more quickly than the carriage is calculated to do, from the top to the sides of a rounded road; *or*, lastly, by turning a sharp corner with too great velocity. In the two first cases the danger arises from the centre of gravity of the total coach and load being placed too high; and in the last instance, of turning the sharp corner, from the same centre (but which we must now consider as the centre of the *vis inertiæ*) being also placed too high. The danger in the two first cases grows often out of the very circumstances of the road, and meets every one's

 comprehension:

Wheel-carriages.

comprehension: the last, which is less obvious, is generally owing to the mere will of the driver; and the better the road, the more is he tempted, without any intention, to go on to produce it: it requires therefore to be more generally understood than it is. It may be thus explained:—A carriage is going along a straight level road at the rate of nine miles an hour: then, though you imagine the horses or pulling power to be in an instant withdrawn, yet will the carriage continue its motion for ten, fifteen, or more yards, and at first with the same velocity, *and in the same straight line, in consequence of the acquired motion.* Supposing, now, the coach with its four horses going the nine miles an hour along a fine level road, but which has *a sharp and sudden corner to turn;*—the coachman knows it, and wishes to keep his velocity; the horses are aware of both—and by the animal dexterity with which they are gifted, *contrive to make the turn* without remitting any thing of their speed. *Not so the coach which follows them;* that has a tendency to persevere *in its straight line;* and the centre of its effort to do so is the centre of its *vis inertiæ*, the very centre of its gravity. If this centre be *low*, the turn of the corner may be made with no other inconvenience than a short awkward slide of the hind wheels, *onward in the original direction;* whereas, if it *be high*, there will be no slide, but *the coach will be overturned*, and overturned nearly at that point where its broadside is at rectangles to the straight line of road it has been thus forced to quit: for at that point the base against such an overturn will be the most disadvantageous, and the check to the onward motion the greatest. The *remedy* offered against all these *causes of the overturn*, (whether by a *ditch*, *bank*, *rounded road*, or *sharp corner*), *is to bring down this centre*, by placing as much of the luggage as possible *in a luggage-box*, *below the body of the carriage;* the body not being higher than usual.

From the *overturn*, we pass to the consideration of the *breaking-down;* this we must reckon on happening as often in these patent stage coaches as in others. Wheels will come off or fail, or axles will break, *in future, as they have done heretofore;* but against the disastrous and fatal consequences of such accidents the remedy offered may be thus described.—On each side of *the luggage-box*, with their periphery below its floor, and each as near as may be requisite to its respective *active wheel*, there is placed a *small strong idle wheel*, *ready* in case of *breaking down, on either side, to catch the falling carriage, and instantly to continue its previous velocity*, till the coachman can pull up his horses, thereby preventing *that sudden stop to rapid motion*, which at present constantly attends the *breaking-down;* and which has so frequently proved fatal to the coachman and outside passengers. In case a fore-wheel comes off, each end of the fore-carriage has its *idle wheel.* By this provision we shall be, *to all effect of safety*, continually travelling with two carriages under us. The bottom of this luggage-box is meant to be about fourteen inches from the ground; and the *idle wheels* seven, six, or five; but if at a still less distance, little inconvenience would result; for when either of them takes over an obstacle in the road, it instantly, and during the need, discharges its respective *active wheel* from the ground, and works in its stead. If these two principles of safety were applied to the description of the several stage-coach accidents we meet with, there is no doubt but a general conviction would arise, *that* the safety by these modes is (in vehicles of all kinds), *perhaps as great as can consist with rapid loco-motion; and that*, sooner or later, *legislative authority*, in some shape or other, may judge it necessary to interpose, for the purpose of controlling a prejudice against *the form essential to this mode of safety.* The trial and proof which these principles have been brought to, have not only been by public exhibition, and with preparation; but *in all the suddenness*, also, *of actual heavy work:* and the result in both cases has been so exactly the same, as to give *continual assurance* of the full effect of the remedy, as often as the casualties of the road shall bring it into action.

Wheel-carriages.

The aim in the arrangement of this *coach of safety*, has been to bring down the load, and consequently the centre of gravity, as low as possible: this is thought to make the coach *look heavy;* and this word, by the ready operation of a prejudice, has been transferred to its going; and one specific reason added withal, that, *because the load is low*, the draught *must* be heavy. This point, however, has, in the presence of 10 or 12 competent persons, been brought to the most decisive proof; and it comes out, that it is as indifferent to draught, as it is material to danger or safety, whether *a ton* be placed on the roof of a coach, or *a ton* on the floor of the patent luggage-box, about 15 or 16 inches from the ground.

It has been asked, "*What would this coach do in snow?*" The question has been thus answered by the result of actual work; for the patent coach, after being detained on the road with several other coaches, by a sudden fall of snow, when at last they started together, *came in six or seven hours before any of them.* They were bound in prudence, to go cautiously along the ground, whose unevenness was invisible; while the patent coach dashed along it with all the confidence and safety of a post-chaise. See Plate DLXXVII.

Wheel-Animal. See Animalcule, N° 16—23.

Wheel, Persian. See Agriculture.

Wheel, Potter's. See Porcelain.

Wheel is also the name of a kind of punishment to which great criminals are put in divers countries. In some, assassins, parricides, and robbers on the highway, are said to be condemned to the wheel, when they are to have their bones first broken with an iron bar on a scaffold, and then to be exposed, and left to expire on the circumference of a wheel. In Germany they break their bones on the wheel itself.—Of this cruel punishment, it is not certain who was the inventor: it was first used in Germany, and was, indeed, but rarely practised anywhere else, till the time of Francis I. of France; who, by an edict of the year 1534, appointed it to be inflicted on robbers on the highway.

WHEELER, Sir George, a learned traveller and divine, was the son of Colonel Wheeler of Charing in Kent, and was born in 1650 at Breda, where his parents as royalists were then in exile. He travelled through various parts of Greece and the East, in company with Dr James Spon of Lyons; and taking orders on his return, was installed a prebend of Durham, made vicar of Basingstoke, and afterward rector of Houghton le Spring. He published an account of his Travels in 1682 in folio; and in 1689, his Observations on Ancient Edifices of Churches yet remaining in the East, compared

WEIGHING. **PLATE DLXXVII.**

Fig. 1.

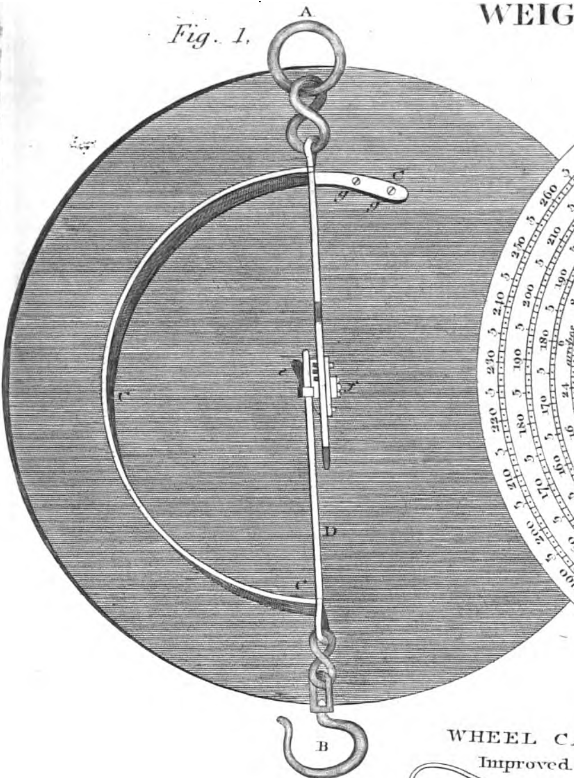
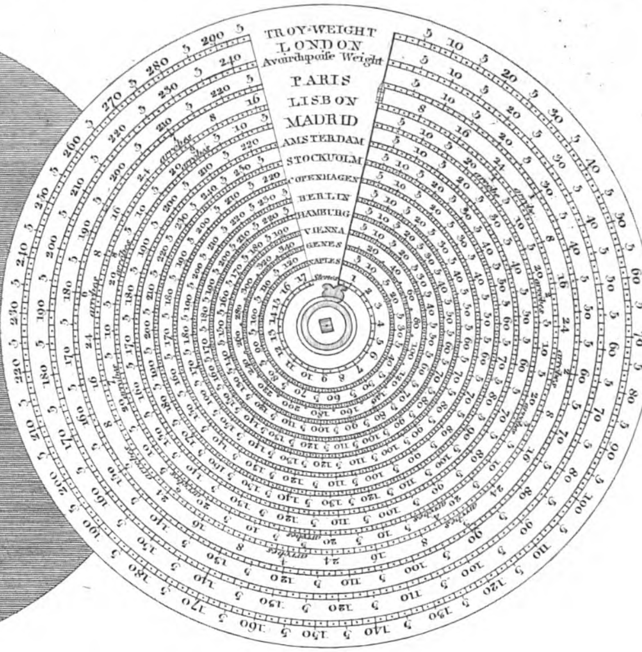
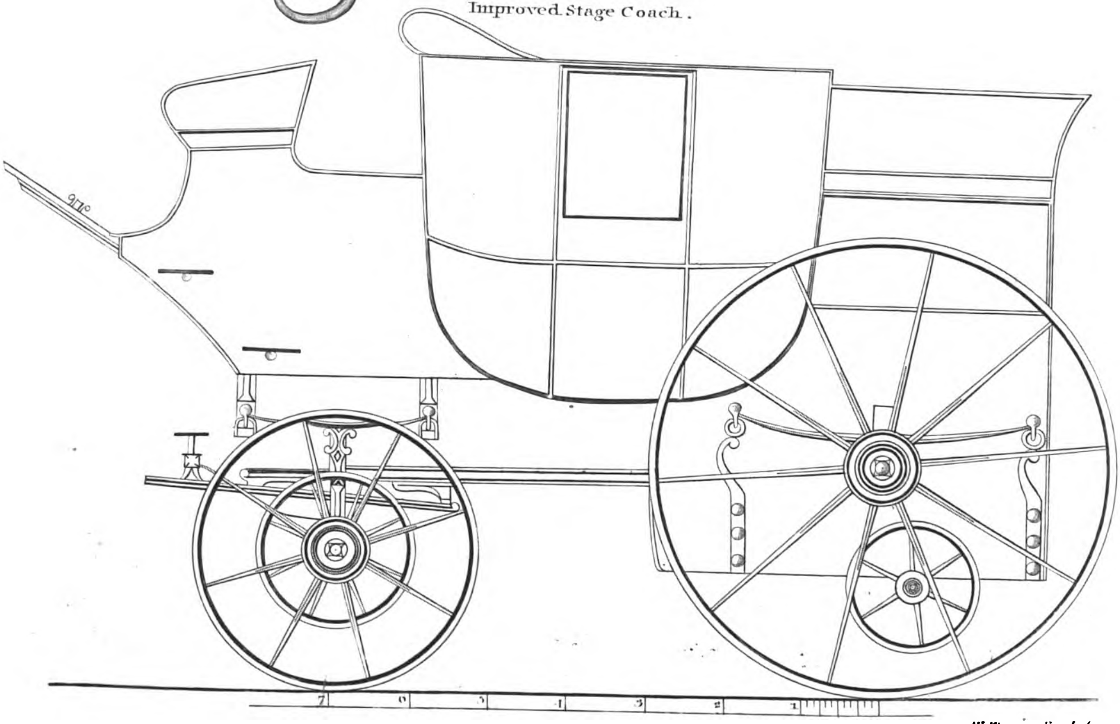


Fig. 2.



WHEEL CARRIAGES

Improved Stage Coach.



compared with Eusebius: also the Protestant Monastery, or Christian Oeconomics. He died in 1724.

WHEELINGS, in the military art, are different motions made both by horse and foot, either to the right and left, or to the right and left about.

General Rules for WHEELING.—The circle is divided into four equal points: thence, wheeling to the right or left, is only a quarter of the circle; wheeling to the right or left about, is one half of the circle.

When you wheel to the right, you are to close to the right, so near as to touch your right-hand man, but without pressing him; and to look to the left, in order to bring the rank about even.

When you wheel to the left, you are to close to the left, and look to the right as above directed. This rule will serve for all the wheeling by ranks; as when a battalion is marching by subdivisions with their ranks open, then each rank wheels distinctly by itself, when it comes to the ground on which the ranks before it wheeled, but not before.

In wheeling, the men are to take particular care neither to open nor close their ranks, and to carry their arms well.

In wheeling, the motion of each man is quicker or slower, according to the distance he is from the right or the left: thus, when you wheel to the right, each man moves quicker than his right-hand man; and wheeling to the left, each man moves quicker than his left-hand man; the circle that every man wheels being larger, according to the distance he is from the hand he wheels to; as may be seen by describing several circles within one another, at two feet distance from each, which is nearly the space every man is supposed to take up.

WHELK, a species of shell-fish. See BUCCINUM, CONCHOLOGY *Index*.

WHELP, the young of a dog, fox, lion, or any wild beast.

WHELPS, in a ship, the seaman's term for those brackets which are set up on the capstan close under the bars; they give the sweep to it, and are so contrived that the cable winding about them may not surge so much as it might otherwise do if the body of the capstan were quite round and smooth.

WHETSTONE, a stone so called, because it serves for the whetting of edge tools upon. See MINERALOGY *Index*.

WHEY, the serum or watery part of milk.

WHIDAH, a kingdom of Africa, on the coast of Guinea, and to the west of the Gold Coast; extending about 10 miles along the sea. It is a populous country, well furnished with large villages; and there are so many small ones, that they are not above a musket-shot from each other.—The houses are small, round at the top, and encompassed with mud walls or hedges, together with a great number of all sorts of beautiful and lofty trees, which afford the most beautiful prospect in the world, insomuch that those that have been here represent it as a perfect paradise. The fields are always green, and they cultivate beans, potatoes, and fruits; nor will the negroes here let a foot of ground remain uncultivated. They sow again the very next day after they have reaped. The inhabitants are greatly civilized, very respectful to each other, especially to their superiors, and very industrious. The women brew the beer, dress the victuals, and sell all sorts of commodities at the market. Those that are rich employ their wives and slaves in tilling the land, and they carry on a considerable trade with the product, as well as in slaves; for some of them are able to deliver 1000 of the latter every month. The chief men have generally 40 or 50 wives, the principal captains 300 or 400, and the king 4000 or 5000. They are extremely jealous, and, on the least suspicion, will sell them to the Europeans for slaves. If any one happen to touch one of the king's wives accidentally, he is doomed to perpetual slavery. It is no wonder then that the women are not fond of being the king's wives; and some of them will prefer a speedy death to such a miserable life. They have no distinction of hours, days, weeks, months, or years. The rite of circumcision is used here; but they are not able to tell why they use it, nor whence it is derived. They are such great gamesters, that they will stake all they have at play, not excepting their wives and children. They have a vast number of idols; and they deify the most contemptible animal that they see first in a morning, and even stocks and stones. Their principal regard is for snakes, very high trees, and the sea. An English factor, just arrived, found a snake in the house belonging to the factory, and killed it without the least scruple; which so incensed the negroes, that they were for revenging the death of the snake, not only upon him that killed it, but upon the whole factory; but by means of presents, and the interposition of the people of the other factories, the affair was made up, and the snake honourably interred. However, to prevent such accidents, they gave them warning not to do the like for the future. They have oxen, cows, goats, sheep, hogs, turkeys, ducks, and hens; which last are extremely plentiful. There are many elephants, buffaloes, tigers, several kinds of deer, and a sort of hares. The fruits are citrons, lemons, oranges, bananas, tamarinds, &c. and they have vast numbers of palm-trees, from which they obtain wine. Whidah was conquered by the king of Dahomy. Their trade consists of slaves, elephants teeth, wax, and honey. The English factory is 200 miles east of Cape Coast Castle, within land. Bows, arrows, beautiful assaguays, and clubs, are the principal weapons of the nation.

WHIDAW-BIRD. See EMBERIZA, ORNITHOLOGY *Index*.

WHIG, a person belonging to a political party in Britain, opposite to the Tories. See TORIES, and BRITAIN.

WHIMBREL. See SCOLOPAX, ORNITHOLOGY *Index*.

WHIN. See ULEX, BOTANY *Index*.

WHINCHAT. See MOTACILLA, ORNITHOLOGY *Index*.

WHIP, or *WHIP-Staff*, in a ship, a piece of timber, in form of a strong staff, fastened into the helm, for the steersman, in small ships, to hold in his hand, in order to move the rudder, and direct the ship.

WHIRLPOOL, an eddy, vortex, or gulf, where the water is continually turning round.

Those in rivers are very common, from various accidents, and are usually very trivial, and of little consequence. In the sea they are more rare, but more dangerous. Sibbald has related the effects of a very remarkable marine whirlpool among the Orcades, which would prove very dangerous to strangers, though it is

of

Whirlpool. Whirlwind.

of no consequence to the people who are used to it. This is not fixed to any particular place, but appears in various parts of the limits of the sea among these islands. Wherever it appears, it is very furious, and boats, &c. would inevitably be drawn in and perish with it; but the people who navigate them are prepared for it, and always carry an empty vessel, a log of wood, or large bundle of straw, or some such thing in the boat with them; as soon as they perceive the whirlpool, they toss this within its vortex, keeping themselves out: this substance, whatever it be, is immediately received into the centre, and carried under water; and as soon as this is done, the surface of the place where the whirlpool was becomes smooth, and they row over it with safety; and in about an hour they see the vortex begin again in some other place, usually at about a mile's distance from the first.

WHIRLWIND, a wind which moves in a spiral direction, as well as horizontally, which is exceedingly rapid and impetuous, but only of short duration.

Dr Franklin's opinion of the origin of whirlwinds has been already given in the article *Water-Spout*. If his theory be true, it will follow, that no hurricane ever can be so violent as to remove an obstacle of the size of only one cubic inch, provided that was supported by a power equivalent to 15 pounds; for this is the utmost force of the atmosphere when rushing into a perfect vacuum, which never could take place in the centre of a whirlwind or water-spout. Indeed, notwithstanding the dreadful effects sometimes observed from hurricanes and whirlwinds, we shall easily perceive, that the utmost of their power always falls very far short of this. The diminution of the specific gravity of the air by only one-fourth in the middle of the column, would produce such an afflux of air from all quarters, that an obstacle presenting a surface of one foot square, would require a force of 504 pounds to prevent it from being carried away; which the strongest walls that can be built by human art could scarce resist. Nay, even the tenth part of this, or the diminution of the gravity of the atmosphere by one-fortieth part, would produce a pressure of upwards of 50 pounds on every square foot of surface, which, it is to be doubted, whether any of our common houses could resist.

Some philosophers ascribe the vacuum in the atmosphere, to which, according to Dr Franklin's theory, whirlwinds are owing, to a stream of electric matter rushing with violence into the atmosphere out of the earth. But they do not inform us how this matter comes to be accumulated in that part of the earth; what induces it to pass out of the earth; how it passes invisibly through pure air; or what serves it for a conductor. It seems to be the fashion among certain philosophers to ascribe every phenomenon, with the cause of which we are unacquainted, to electricity. But this is merely substituting a new name, and serves rather to retard than advance our knowledge of nature.

Some kinds of whirlwinds move with a slow motion, and are injurious only by their vortex; while others seem to do mischief as well by their progressive as their whirling motion. Of this kind are those called *typhons*; which, by their frequently following the course of rivers, seem thus also to discover their electrical origin. Of the destructive effects of these, we have an instance in what happened in Charlestown in South Carolina, on the 1st of June 1761. It was first observed about noon on land, upwards of 50 miles west by south of Charlestown, and destroyed several houses, &c. as it passed along, in many places making wide avenues through the woods; from whence every tree and shrub was torn up, and great branches of trees were driven about in the column as it passed along. It directed its course to Ashley river, down which it came with surprising velocity; in its appearance resembling a column of smoke or vapour, whose motion was very irregular and tumultuous. Its momentum was so great, that Ashley river was ploughed to the bottom, and the channel laid bare. As it came down this river, it made a constant noise like thunder; its diameter being computed about 300 fathoms. It was met at White Point by another of the same kind which came down Cooper's river, but with inferior strength; however, on their meeting together, the agitation of the air was much greater, while the clouds, which were driving in all directions to the place, seemed to be precipitated, and whirled round with incredible velocity. It then fell upon the shipping in the road; entirely destroying some, and damaging others; being scarce three minutes in its passage, though the distance was near two leagues. In that short time it did damage to the amount of 20,000l.; and had not its direction been altered by that gust which came down Cooper's river, it must have totally destroyed Charlestown, as no obstacle whatever seemed capable of resisting its fury.

WHISKY, a term signifying *water*, and applied in Scotland and in Ireland to a distilled liquor drawn from barley,

WHISPERING-PLACES. See Acoustics, N° 24.

WHIST, a well known game at cards, which requires great attention and silence; hence the name.

This game is played by four persons, who cut for partners; the two highest and the two lowest are together, and the partners sit opposite to each other: the person who cuts the lowest card is to deal first, giving one at a time to each person, till he comes to the last card, which is turned up for the trump, and remains on the table till each person has played a card. The person on the left hand side of the dealer plays first, and whoever wins the trick is to play again, thus going on till the cards are played out. The ace, king, queen, and knave of trumps, are called *honours*; in case any three of these honours have been played between, or by either of the two partners, they reckon for two points towards the game; and if the four honours have been played between, or by either of the two partners, they reckon for four points towards the game, the game consisting of ten points. The honours are reckoned after the tricks; all above six tricks reckoning also towards the game.

General Rules for playing the Game of Whist.—

1. He who is to play first should lead from the strongest suit. If he has a sequence of king, queen, and knave, or queen, knave and ten, he may safely lead the highest of the sequence; but if he has five or six in number, he must begin with the lowest. He must always begin with the highest trump, by which he forces out the superior trumps, and can come in again, to make his strong suit.

2. He should never be afraid to play trumps when he has five in his hand, even of the smallest, although he may not have any good cards of any other suit.

3. With

3. With ace and king of any two suits, and only two or three small trumps, the aces and kings should be played out, in order to make as many tricks as possible; and having but two or three small trumps, he should never force his partner to trump, if he finds he cannot follow suit; but endeavour to throw the lead into his partner's hand.

4. He should in general return his partner's lead, unless he has some capital cards of his own.

5. As this game is played with the lurch, that is, to save half the stake, five points must be made before the game is out: he should not venture to play trumps when he is four of the game, unless he is very strong, having at least an honour and three trumps, or ace, king, and two small ones.

6. When the game is scored nine, at which stage the honours reckon for nothing, he should be still more cautious how he plays trumps, even if he is strong in hand, and give his partner an opportunity of trumping the adversaries suits, in case he is deficient in them.

7. If his adversaries are six or seven love of the game, he should play a forward or bold game, that he may have a chance, at the risk of a trick or two, to come up with them. If he has but three trumps and other good cards, he may play trumps, especially if he has a sequence, or queen, knave, and a small one.

8. He should always risk a trick or two when the game is much in his favour; because a new deal is of greater consequence to the adversary than one or two points are to him.

9. When the player finds there is a likelihood of either saving the game or his lurch, he should risk the odd trick; but if the game is five all, and he can make two tricks in his own hand, he should make them, in order to secure the difference of two points, which make the game near two to one in his favour.

10. A good player should begin with a small trump, when he has ace, king, and four small ones; for this reason, if his partner has a better trump than the last player, which is an equal wager but he has, he has a chance of fetching out all the trumps, by having three rounds of them.

11. The odds are always in his favour that his partner holds an honour; consequently if he has king, queen, and four small ones, he should begin with a small one.

12. When queen, knave, and four small trumps are dealt him, he should play a small one first, the odds being in his favour that his partner holds an honour; if he has knave, ten, and four small trumps, he should also begin with a small one, for the same reason.

13. If he has knave, ten, eight, and three small trumps, the knave should be played first, by which means the nine may be prevented from winning a trick, the odds being in his favour that three honours are played in two rounds.

14. If an honour is turned up against him on his left hand, and he has ten, nine, and eight, with two or three small trumps; when he is to play, he should play through the honours with the ten, which will force the dealer to play his honour to a disadvantage, if the dealer does not choose to leave it to the option of his adversary whether he will pass it or not; but if he has six trumps of a lower denomination, and not ten, nine, and eight, and no honour turned up against him, he should begin with a small one.

15. In general, when he has two capital cards in trumps, and two or three small ones, he should begin with a small one, for the reason assigned in N° 12.

16. When he has ace, king, knave, and two small trumps, or even one small trump, by first playing the king, and putting the lead into his partner's hand, who will play a trump; judging him to have ace and knave, from his beginning with the king: in this case the knave should be finessed (A), nothing being against him but the queen.

17. If he has knave, ten, eight, and two small trumps, by playing the knave first, it is odds but in two rounds of trumps the nine falls, or he may finesse the eight when his partner returns trumps.

18. With five trumps of a lower denomination, he should begin with the smallest, unless he has a sequence of ten, nine, and eight; then he should begin with the ten.

19. When he has king, queen, ten, and one small trump, he must begin with the king, and wait for his partner's return of the trumps, in order to finesse the ten, by which means he may win the knave.

20. In order to prevent the ten from winning, when he has queen, knave, nine, and one small trump, he must begin with the queen. And in case he has knave, ten, eight, and one small trump, he should begin with the knave, that the nine may not win.

21. If he has ten, nine, eight, and one small trump, he should begin with the ten; thereby he strengthens his partner's hand, leaving it at his option to take it or not.

22. He should begin with a small one, when he has the ten and three small trumps.

23. If he has a good suit, and ace, king, and four small trumps, he must play three rounds of trumps, in order to secure his strong suit from being trumped.

24. When he has king, queen, ten, and three small trumps, he should begin with the king, because he has a chance of the knaves's coming down in the second round; and to secure his strong suit, he should not wait to finesse the ten. If he should have queen, knave, and three small trumps, and some good suit to make, he must begin with a small one.

25. If he has knave, ten, eight, and two small trumps, with a strong suit, he should begin with the knave, in order to make the nine fall in the second round; but if he has knave, ten, and three small trumps, with a good suit, he should play a small one first.

26. With ten, nine, eight, and one small trump, provided he has a good suit, he should begin with the ten; by which means he may get the trumps out, and have a chance of making his strong suit.

The following observations will enable a player to know that his partner has no more of a suit which either of

(A) *Finesse*, is to play a small card which may win, keeping the superior card or cards to lay over the right-hand adversary.

Whist. of them has played. Suppose he leads from queen, ten, nine, and two small cards of any suit, the second hand puts on the knave, his partner plays the eight; in this case, he having queen, ten, and nine, it is a demonstration, if his partner plays well, that he can have no more of that suit. By that discovery, he may play his game accordingly, either by forcing his partner to trump that suit, if he is strong in trumps, or by playing another suit. If he has king, queen, and ten of a suit, and he leads his king, his partner plays the knave; this also demonstrates he has no more of that suit. If he has king, queen, and many more of a suit, and begins with the king, in some cases it is good play in a partner, when he has the ace and one small card in that suit only, to win the king with the ace; for suppose the partner to be very strong in trumps, by taking the king with the ace, he gets the lead and trumps out, and having cleared the board of trumps, his partner returns his lead; and the ace being out, there is room for him to make that whole suit, which could not have been done if the partner had kept the ace. Suppose he has no other good card in his hand besides that suit, he loses nothing by the ace's taking his king; and if it should so happen that he has a good card to bring in that suit, he gains all the tricks which he makes to that suit by this method of play: as his partner has taken his king with the ace, and trumps out upon it, he has reason to imagine that his partner has one of that suit to return him; for which reason he should not throw away any of that suit, even to keep a king or queen guarded.

Method of playing when an honour is turned up on the right hand.—Suppose the knave is turned up on his right hand, and that he has king, queen, and ten; in order to win the knave, he must begin with the king; by which means, his partner may suppose him to have queen and ten remaining, especially if he has a second lead, and he does not proceed to play the queen.

Suppose the knave turned up as before, and he has ace, queen, and ten, by playing his queen, it answers the purpose of the former rule.

When the queen is turned up on his right hand, and he has ace, king, and knave, by playing his king, it answers the same purpose of the former rule.

In case an honour is turned up on his left hand, supposing he should hold no honour, he should play trumps through the honour as soon as he gets the lead; but if he should hold an honour (except the ace), he must be cautious how he plays trumps, because, in case his partner holds no honour, his adversary will play his own game upon him.

Method of playing the sequences.—The highest in sequences of trumps should be played, unless he has ace, king, and queen; and then he should play the lowest, which informs his partner of the state of his game.

When he has king, queen, and knave, and two small ones, which are not trumps, he should begin with the knave, whether he is strong in trumps or not, as he makes way for the whole suit by getting the ace out.

If he is strong in trumps, and has a sequence of queen, knave, ten, and two small cards of a suit, he should play the highest of his sequence; for if either of the adversaries should trump that suit in the second round, being also strong in trumps, he will make the remainder of that suit, by fetching out the trumps. When he has knave, ten, and nine, and two small cards of a suit, he may play in the like manner.

If king, queen, and knave, and one small card of any suit, is the case, whether strong in trumps or not, he should play the king; and when there are only four in number, the same method of play should be observed by inferior sequences.

When weak in trumps, he should begin by the lowest of the sequence, provided he has five in number, because if his partner has the ace of that suit he will make it. If he has the ace and four small cards of a suit, and weak in trumps, leading from that suit, he should play the ace. When strong in trumps, the game may be played otherwise.

How to make a flam, or *win every trick.*—Suppose A and B partners against C and D, and C to deal, A to have the king, knave, and nine, and seven of hearts, which are trumps, a quart-major in spades, a tierce-major in diamonds, and the ace and king of clubs. Then suppose B to have nine spades, two clubs, and two diamonds. Also suppose D to have ace, queen, ten, and eight of trumps, with nine clubs, and C to have five trumps and eight diamonds. A leads a trump, which D wins, and D is to play a club, which his partner C is to trump; C leads a trump, which his partner D wins; D then will lead a club, which C will trump; and C will play a trump, which D will win; and D having the best trump will play it; after which D having seven clubs in his hand, makes them, so that he flams A and B.

How to play any hand of cards according to the nearest calculations of his partner's holding certain winning cards:

1. That he has not one certain winning card, is - - -	2 to 1
2. That he has not two certain winning cards, is - - -	17 to 2
But it is about 5 to 4 that he has one or both, or - - -	32 to 25
3. That he has one card out of any three certain winning cards, is about	5 to 2
4. That he has not three certain winning cards is about 31 to 1, or -	681 to 22
5. That he has not two of them, is about 7 to 2, or - - -	547 to 156
6. That he has not one of them, is about 7 to 6, or - - -	378 to 325
7. That he holds one or two of them, is in his favour about 13 to 6, or	481 to 222
8. And about 5 to 2, that he holds 1, 2, or all three of them.	

The use of these calculations is for a whist-player to play his cards to the most advantage. For instance,

As the first calculation is two to one that his partner does not hold one certain winning card.—Suppose then a suit is led, of which the second player has the king and a small one only, he should put on the king, because the odds are in his favour, that the third player cannot win it. For the same reason, when he is second player, and to lead, he should play a king in preference to a queen, because it is two to one the ace does not take it; but it is five to four the queen will be taken by either ace or king, which may be in the third hand.

According

Whist, Whiston.

According to the second calculation, of its being five to four that his partner holds one certain winning card out of any two: If he has two honours in any suit, he can play to an advantage, knowing it is five to four in favour of his partner's having one of the two honours; and by the same rule, if he is second player, having a queen and one small card, by playing the queen he plays five to four against himself.

It is obvious, from the third calculation, which proves it to be five to two that his partner has one card out of any three certain winning cards, that he who plays the knave second hand, having but the knave and one small card of the same suit, must play five to two against himself, and discovers his game to a great disadvantage; for which reason, he should play the lowest of any sequence which he may hold in his hand, as the knave, if he has king, queen, and knave; the ten, if he has queen, knave, and ten, &c. By so doing, his partner has an opportunity of judging what card to play in that suit, according to the odds for or against him.

The Hoyle's games improved by Beaufort.

From the above calculation, if he has ace, king, and two small trumps, he is entitled to win four tricks out of six, provided he has four winning cards of any suit; or five tricks out of seven, if he has five winning cards of any suit: by playing two rounds of trumps, and taking out eight of them, it is five to two but his partner has a third trump; and if it should be so, he makes the tricks intended.

WHISTON, William, an English divine of great parts, uncommon learning, and of singular character, was born in 1667 at Norton near Twycrosse in the county of Leicester, where his father was rector. He was admitted of Clarehall, Cambridge, where he pursued his studies, particularly in the mathematics, and commenced tutor; which his ill health at length forced him to decline. Having entered into orders, he became chaplain to Dr More bishop of Norwich in 1694; and in this station he published his first work, entitled A New Theory of the Earth, &c. in which he undertook to prove the Mosaic doctrine of the earth perfectly agreeable to reason and philosophy. This work brought no small reputation to the author. In the beginning of the 18th century he was made Sir Isaac Newton's deputy, and afterwards his successor, in the Lucasian professorship of mathematics; when he resigned a living he had in Suffolk, and went to reside at Cambridge. About this time he published several scientifical works, explanatory of the Newtonian philosophy; and he had the honour to be one of the first, if not the very first, who rendered these principles popular and intelligible to the generality of readers. About the year 1710, he was known to have adopted Arian principles, and was forming projects to support and propagate them: among other things, he had translated the Apostolic Constitutions into English, which favoured the Arian doctrine, and which he asserted to be genuine. The consequence was, that he was deprived of his professorship, and banished the university; he nevertheless pursued his scheme, by publishing the next year his Primitive Christianity Revived, 4 vols. 8vo, for which the convocation fell upon him very vehemently. On his expulsion from Cambridge, Mr Whiston settled in London; where, without suffering his zeal to be intimidated, he continued to write, and propagate his Primitive Christianity, with as much ardour as if he had been in the most flourishing circumstances. In 1721, a subscription was made for the support of his family, which amounted to 470l. For though he drew profits from reading astronomical and philosophical lectures, and also from his publications, which were very numerous, yet these of themselves would have been very insufficient: nor, when joined with the benevolence and charity of those who loved and esteemed him for his learning, integrity, and piety, did they prevent his being frequently in great distress. He continued long a member of the church of England, and regularly frequented its service, though he disapproved of many things in it: but at last he went over to the Baptists, and attended Dr Forster's meeting at Pinner's hall, Broadstreet. Among other performances not specified above, he wrote Memoirs of his own life and writings, which contain some curious particulars.

Whiston, Whitby.

He was remarkable for speaking the plainest truths on every occasion, and to persons of every degree. During the year 1725, that he, with Dr Clarke, Dr Berkeley, and others, had the honour to attend Queen Caroline on a certain day of every week, to talk of the progress of science, her majesty one evening took occasion to pay him a just compliment on his truth and integrity, requesting that he would, with his usual plainness, point out to her any fault that he might have observed in her conduct. At first he begged to be excused, adding, that few persons could bear to have their faults plainly told to them, and least of all royal personages, who, from their elevation, are necessarily surrounded by flatterers, to whose lips truth is a stranger. Her majesty replied, that he was to consider her not as a queen, but as a philosopher; and that philosophy is of very little use, if it cannot enable its professors to bear without offence truths necessary to their own improvement. Upon this he told her, that the greatest fault which he had observed in her conduct, was her indecent behaviour in the house of God, which, he assured her, had made very unfavourable impressions on the minds of many persons, who coming to town from distant parts of the country, had gone to the chapel to obtain a sight of her majesty, the king, and the royal family. The queen made no reply; but in about six weeks afterwards renewed her request, that Mr Whiston would point out the most glaring improprieties in her conduct. To this he answered, that he had laid down a maxim, from which he could not deviate, never to point out to any person more than one fault at a time, and never to give a second reproof till he had observed some good consequence to have arisen from the first (A). Much to the queen's honour, she was pleased with this plain-dealing, and continued to think favourably of Mr Whiston. This honest, but whimsical and credulous man, died in 1762, at the advanced age of 95.

WHITBY, Dr Daniel, a very learned English divine, was born in 1638, and bred at Oxford; where in 1664, he was elected perpetual fellow of his college. He afterwards became chaplain to Dr Seth Ward, bishop

(A) Bishop Berkeley was present at these conversations, and from his son we received the account we have given of them. They are likewise mentioned, but not stated so accurately, by Bishop Newton in his own Life.

Whitby ‖ Whitefield.

shop of Salisbury; who collated him in 1668 to the prebend of Yatesbury in that church, and soon after to that of Husborn and Burbach. In 1672 he was admitted chanter of the said church, on the death of Mr John South, and then, or soon after, rector of St Edmund's church in Salisbury. He was made a prebendary of Taunton Regis in 1696, and died in 1726. He was ever strangely ignorant of worldly affairs, even to a degree that is scarcely to be conceived. His writings are numerous, and well known; particularly his Commentary on the New Testament.

WHITBY, a sea-port town in the north riding of Yorkshire, seated on the river Esk, near the place where it falls into the sea. The houses are neat, strong, and convenient; the number of inhabitants in 1811 was 6969. Ship-building is their principal employment. W. Long. 0. 24. N. Lat. 54. 30.

WHITE, one of the colours of natural bodies.

White of the Eye, denotes the first tunic or coat of the eye, called *albuginea*. See ANATOMY, N° 142.

White of Egg. See ALBUMEN and EGG.

White Friars, a name common to several orders of monks, from being clothed in a white habit.

White Sea, is a bay of the Frozen ocean, so called in the north part of Muscovy, lying between Russian Lapland and Samoieda; at the bottom of which stands the city of Archangel. This was the chief port the Russians had before their conquest of Livonia.

White Colour, white lead for painting. See CHEMISTRY, N° 1856.

White Iron, or *Tin-plate*, iron-plates covered over with tin; for the method of making which, see LATTEN, CHEMISTRY, N° 1956.

In 1681 tin-plates were manufactured in England by one Andrew Yarranton, who had been sent to Bohemia to learn the method of making them. But the manufacture was soon afterwards discontinued. It was revived in 1740, and has now arrived at as great, if not greater, perfection in this country than in any other.

White Lead. See CHEMISTRY, N° 1856.

White-Throat. See MOTACILLA, ORNITHOLOGY *Index*.

WHITEFIELD, GEORGE, the celebrated preacher among the people called *Methodists*, was born in the year 1714, at the Bell in the city of Gloucester, which was then kept by his mother. At about 12 years of age he was put to a grammar-school; but his mother entering into a second marriage, which proved a disadvantageous one, he, when about 15, put on a blue apron, and served her in the capacity of a drawer or waiter. After continuing about a year in this servile employment, she turned over the business to his brother; who marrying, and George not agreeing with his sister-in-law, he left the inn. Some time after, meeting with an old school-fellow, then a servitor in Pembroke college, Oxford, he was induced to attempt getting into the same college in a like capacity, and succeeded. Here Mr Whitefield, who from his own account appears to have always had a strong tincture of enthusiasm in his constitution from his very childhood, distinguished himself by the austerity of his devotion, and acquired considerable eminence in some religious assemblies in that city. At the age of 21, the fame of his piety recommended him so effectually to Dr Benson, then bishop of Gloucester, that he made him a voluntary offer of ordination. Immediately after this regular admission into the ministry, Mr Whitefield applied himself to the most extraordinary, the most indefatigable, duties of his character, preaching daily in prisons, fields, and open streets, wherever he thought there would be a likelihood of making proselytes. Having at length made himself universally known in England, he embarked for America, where the tenets of Methodism began to spread very fast under his friends the Wesleys; and first determined upon the institution of the orphan-house at Georgia, which he afterwards effected. After a long course of peregrination, his fortune increased as his fame extended among his followers, and he erected two very extensive buildings for public worship, under the name of *Tabernacles*; one in Tottenham-Court Road, and the other in Moorfields. Here, with the help of some assistants, he continued for several years, attended by very crowded congregations, and quitting the kingdom only occasionally. Besides the two tabernacles already mentioned, Mr Whitefield, by being chaplain to the countess dowager of Huntingdon, was connected with two other religious meetings, one at Bath, and the other at Tunbridge, chiefly erected under that lady's patronage. By a lively, fertile, and penetrating genius, by the most unwearied zeal, and by a forcible and persuasive delivery, he never failed of the desired effect upon his ever crowded and admiring audiences. In America, however, which always engaged much of his attention, he was destined to finish his course; and he died at Newberry, about 40 miles from Boston in New England, in 1770.

WHITEHAVEN, a sea-port town of Cumberland, with a market on Tuesday, and containing 10,106 inhabitants in 1811. It is seated on a creek of the Irish sea, on the north end of a great hill, washed by the tide of flood on the west side, where there is a large rock or quarry of hard white stone, which gives name to the place, and which, with the help of a strong stone-wall, secures the harbour, into which small barks may enter. It is lately much improved in its buildings, and noted for its trade in pit-coal and salt, there being near it a valuable coal-mine, which runs a considerable way under the sea. They have a custom-house here; and they carry on a good trado to Ireland, Scotland, Chester, Bristol, and other parts. It is 10 miles south-west of Cockermouth, and 305 north-west of London. W. Long. 2. 55. N. Lat. 55. 30.

WHITENESS, the quality which denominates or constitutes a body white.

WHITES, or FLUOR *Albus*. See MEDICINE, N° 250.

WHITING. See GADUS, ICHTHYOLOGY *Index*.

WHITLOW, or WHITLOE. See SURGERY *Index*.

WHITSUN-FARTHINGS, otherwise called *Smoke-farthings* or *Quadrantes Pentecostales*, a composition for offerings which were anciently made in Whitsun-week by every man in England, who occupied a house with a chimney, to the cathedral church of the diocese in which he lived.

WHITSUNDAY, a solemn festival of the Christian church, observed on the fiftieth day after Easter, in memory of the descent of the Holy Ghost upon the apostles in the visible appearance of fiery cloven tongues, and of those miraculous powers which were then conferred upon them.

It

Whitsunday ‖ Whytt.

It is called *Whitsunday*, or *White Sunday;* because this being one of the stated times for baptism in the ancient church, those who were baptized put on white garments, as types of that spiritual purity they received in baptism. As the descent of the Holy Ghost upon the apostles happened upon the day which the Jews called *Pentecost*, this festival retained the name of *Pentecost* among the Christians.

Whitsunday Isle, one of the New Hebrides, which lies about four miles to the south, runs in the same direction, and is of the same length, having more sloping exposures than Aurora: it appears to be better inhabited, and to contain more plantations.

WHORTLEBERRY. See Vaccinium, Botany *Index*.

WHYTT, Dr Robert, an eminent physician, born at Edinburgh on the 6th September 1714, was the son of Robert Whytt, Esq. of Bennochy, advocate. This gentleman died six months before the birth of our author, who had also the misfortune to be deprived of his mother before he had attained the seventh year of his age. After receiving the first rudiments of school-education, he was sent to the university of St Andrew's; and after the usual course of instruction there, in classical, philosophical, and mathematical learning, he came to Edinburgh, where he entered upon the study of medicine, under those eminent medical teachers, Monro, Rutherford, Sinclair, Plummer, Alston, and Innes. After learning what was to be acquired at this university, in the prosecution of his studies he visited foreign countries; and after attending the most eminent teachers at London, Paris, and Leyden, he had the degree of Doctor of Physic conferred upon him by the university of Rheims in 1736, being then in the 22d year of his age.

Upon his return to his native country, he had the same honour also conferred upon him by the university of St Andrew's; where he had before obtained, with applause, the degree of Master of Arts.

Not long afterwards, in the year 1737, he was admitted a Licentiate of Medicine by the Royal College of Physicians of Edinburgh; and the year following he was raised to the rank of a Fellow of the College. From the time of his admission as a licentiate, he entered upon the practice of physic at Edinburgh; and the reputation which he acquired for medical learning, pointed him out as a fit successor for the first vacant chair in the university. Accordingly, when Dr Sinclair, whose eminent medical abilities, and persuasive powers of oratory, had contributed not a little to the rapid advancement of the medical school of Edinburgh, found that those conspicuous talents which he possessed could no longer be exerted in the manner which they once had been, when he enjoyed bodily vigour unimpaired by age and powers of mind unclouded by disease, he resigned his academical appointments in favour of Dr Whytt.

This admission into the college took place on the 20th of June 1746; and he began his first course of the institutions of medicine at the commencement of the next winter-session. The abilities which he displayed from his academical chair, in no particular disappointed the expectations which had been formed of his lectures. The Latin tongue was the language of the university of Edinburgh; and he both spoke and wrote in Latin with singular propriety, elegance, and perspicuity. At that time the system and sentiments of Dr Boerhaave, which, notwithstanding their errors, must challenge the admiration of latest ages, were very generally received by the most intelligent physicians in Britain. Dr Whytt had no such idle ardour for novelties as to throw them entirely aside because he could not follow them in every particular. The institutions of Dr Boerhaave, therefore, furnished him with a text for his lectures; and he was no less successful in explaining, illustrating, and establishing the sentiments of the author, when he could freely adopt them, than in refuting them by clear, connected, and decisive arguments, when he had occasion to differ from him. The opinions which he himself proposed, were delivered and enforced with such acuteness of invention, such display of facts and force of argument, as could rarely fail to gain universal assent from his numerous auditors; but free from that self-sufficiency which is ever the offspring of ignorance and conceit, he delivered his conclusions with becoming modesty and diffidence.

From the time that he first entered upon an academical appointment, till the year 1756, his prelections were confined to the institutions of medicine alone. But at that period his learned colleague Dr Rutherford, who then filled the practical chair, who had already taught medicine at Edinburgh with universal applause for more than thirty years, and who had been the first to begin the institution of clinical lectures at the Royal Infirmary, found it necessary to retire from the fatiguing duties of an office to which the progress of age rendered him unequal. On this crisis Dr Whytt, Dr Monro, sen. and Dr Cullen, each agreed to take a share in an appointment in which their united exertions promised the highest advantages to the university. By this arrangement students, who had an opportunity of daily witnessing the practice of three such teachers, and of hearing the grounds of that practice explained, could not fail to derive the most solid advantages.

In these two departments, the institutions of medicine in the university, and the clinical lectures in the Royal Infirmary, Dr Whytt's academical labours were attended with the most beneficial consequences both to the students and to the university. But not long after the period we have last mentioned, his lectures on the former of these subjects underwent a considerable change. About this time the illustrious Gaubius, who had succeeded to the chair of Boerhaave, favoured the world with his *Institutiones Pathologiæ*. This branch of medicine had indeed a place in the text which Dr Whytt formerly followed; but, without detracting from the character of Dr Boerhaave, it may justly be said, that the attention he had bestowed upon it was not equal to its importance. Dr Whytt was sensible of the improved state in which pathology now appeared in the writings of Boerhaave's successor; and he made no delay in availing himself of the advantages which were then afforded.

In the year 1762, his pathological lectures were entirely new-modelled. Following the publication of Gaubius as a text, he delivered a comment, which was read by every intelligent student with the most unfeigned satisfaction. In these lectures he collected and condensed the fruits of accurate observation and long experience. Enriched by all the opportunities of information

 which

Whytt. which had enjoyed, and by all the discernment which he was capable of exerting, they were justly considered as his most finished production.

For a period of more than twenty years, during which he was justly held in the highest esteem as a lecturer at Edinburgh, it may readily be supposed that the extent of his practice corresponded to his reputation. In fact, he received both the first emoluments, and the highest honours, which could here be obtained. With extensive practice in Edinburgh, he had numerous consultations from other places. His opinion on medical subjects was daily requested by his most eminent contemporaries in every part of Britain. Foreigners of the first distinction, and celebrated physicians in the most remote parts of the British empire, courted an intercourse with him by letter. Besides private testimonies of esteem, many public marks of honour were conferred upon him both at home and abroad. In 1752, he was elected a fellow of the Royal Society of London; in 1761, he was appointed first physician to the king of Scotland; and in 1764, he was chosen president of the Royal College of Physicians at Edinburgh.

But the fame which Dr Whytt acquired as a practitioner and teacher of medicine, were not a little increased by the information which he communicated to the medical world in different publications. His celebrity as an author was still more extensive than his reputation as a professor.

His first publication, An Essay on the Vital and other Involuntary Motions of Animals, although it had been begun soon after he had finished his academical course of medical education, did not come from the press till 1751; a period of fifteen years from the time that he had finished his academical course, and obtained a degree in medicine: but the delay of this publication was fully compensated by the matter which it contained, and the improved form under which it appeared.

The next subject which employed the pen of Dr Whytt was one of a nature more immediately practical. His Essay on the Virtues of Lime-water and Soap in the Cure of the Stone, first made its appearance in a separate volume in 1752. Part of this second work had appeared several years before in the Edinburgh Medical Essays: but it was now presented to the world as a distinct publication, with many improvements and additions.

His third work, intitled Physiological Essays, was first published in the year 1755. This treatise consisted of two parts; 1st, An Inquiry into the Causes which promote the Circulation of the Fluids in the very small Vessels of Animals; and 2dly, Observations on the Sensibility and Irritability of the Parts of Men and other Animals, occasioned by Dr Haller's treatise on that subject. The former of these may be considered as an extension and farther illustration of the sentiments which he had already delivered in his Essay on the Vital Motions, while the latter was on a subject of a controversial nature. In both he displayed that acuteness of genius and strength of judgment which appeared in his former writings.

From the time at which his Physiological Essays were published, several years were probably employed by our author in preparing for the press a larger and perhaps a more important work than any yet mentioned, his Observations on the Nature, Causes, and Cure of those Disorders which are commonly called *nervous*, *hypochondriac*, and *hysteric*. The elaborate and useful work was published in the year 1764.

The last of Dr Whytt's writings is entitled, Observations on the Dropsy in the Brain. This treatise did not appear till two years after his death; when all his other works were collected and published in one quarto volume, under the direction of his son and of his intimate friend the late Sir John Pringle.

Besides these five works, he wrote many other papers, which appeared in different periodical publications; particularly in the Philosophical Transactions, the Medical Essays, the Medical Observations, and the Physical and Literary Essays.

At an early period of life, soon after he had settled as a medical practitioner in Edinburgh, he entered into the married state. His first wife was Miss Robertson, sister to General Robertson, governor of New York. By her he had two children; both of whom died in early infancy, and their mother did not long survive them. A few years after the death of his first wife, he married as a second wife Miss Balfour, sister to James Balfour, Esq. of Pilrig. By her he had fourteen children; but in these also he was in some respects unfortunate; for six of them only survived him, three sons and three daughters, and of the former two are since dead. Although the feeling heart of Dr Whytt, amidst the distresses of his family, must have often suffered that uneasiness and anxiety which in such circumstances is the unavoidable consequence of parental affection and conjugal love; yet he enjoyed a large share of matrimonial felicity. But his course of happiness was terminated by the death of his wife, which happened in the year 1764: and it is not improbable that this event had some share in hastening his own death; for in the beginning of the year 1765 his health was so far impaired, that he became incapable of his former exertions. A tedious complication of chronical ailments, which chiefly appeared under the form of diabetes, was not to be resisted by all the medical skill which Edinburgh could afford; and at length terminated in death, on the 15th of April 1766, in the 52d of his age.

WIBURGH, a considerable town of Denmark, in North Jutland, with a bishop's see, remarkable for being the seat of the chief court of justice in the province. The hall where the council assembles has the archives of the country, and escaped the terrible fire that happened in the year 1726, and which burned the cathedral church, that of the Black Friars, the town-house, and the bishop's palace; but they have all been rebuilt more magnificent than before. It is seated on the lake Weter, in a peninsula, 25 miles north-west of Sleswick, and 110 north-by-west of Copenhagen. E. Long. 9. 50. N. Lat. 56. 20.

WICK, a royal borough on the east coast of the county of Caithness. It is small, and the streets narrow, but a few of its buildings are an ornament to the place. The present harbour is very inconvenient, but it is proposed to erect a new one, which will be of great importance to the safety of navigation along that coast. The population of the whole parish in 1793 amounted to 5000; that of the town alone, in 1811, 5080.

WICKER, signifies made of small twigs.

WICKET, a small door in the gate of a fortified place,

place, &c. or a hole in a door through which to view what passes without.

WICKLIFF, John, the first divine in Europe who had resolution to attempt a reformation of religion, was born about the year 1324, in the parish of Wycliff, near Richmond, in Yorkshire. He was educated at Oxford, first in Queen's and afterwards in Merton college, of which he was a probationer fellow. Having acquired the reputation of a man of great learning and abilities, in 1361 he was chosen master of Baliol-hall, and in 1365 constituted warden of Canterbury college, by the founder, Archbishop Simon de Islip; but in 1367, he was ejected by the regulars, together with three secular fellows. He thought their proceedings arbitrary, and therefore appealed to the pope; but instead of obtaining redress, the ejectment was confirmed in 1370. This disappointment probably contributed somewhat towards his enmity to the see of Rome, or rather to confirm that enmity; for he had long before written against the pope's exactions and corruptions of religion. However, his credit in the university continued; for having taken the degree of doctor in divinity, he read public lectures with great applause; in which he frequently exposed the impositions of the Mendicant friars. About this time he published a defence of his sovereign Edward III. against the pope, who had insisted on the homage to which his predecessor King John had agreed. This defence was the cause of Wickliff's introduction at court, and of his being sent one of the ambassadors in 1374 to Bruges, where they met the pope's nuncios, in order to settle several ecclesiastical matters relative to the pope's authority. In the mean time Wickliff was presented by the king to the rectory of Lutterworth in Leicestershire, and in 1375 he obtained a prebend in the church of Westbury in Gloucestershire. Wickliff continued hitherto, without molestation, to oppose the papal authority; but in 1377 a bull was sent over to the archbishop of Canterbury, and to Courtney bishop of London, ordering them to secure this arch-heretic, and lay him in irons; at the same time the pope wrote to the king, requesting him to favour the bishops in the prosecution; he also sent a bull to Oxford, commanding the university to give him up. Before these bulls reached England Edward III. was dead; and Wickliff, protected by John duke of Lancaster, uncle to Richard II. favoured by the queen-mother, and supported by the citizens of London, eluded the persecution of Pope Gregory IX. who died in 1378. In the following year this intrepid reformer presented to parliament a severe paper against the tyranny of Rome, wrote against the papal supremacy and infallibility, and published a book *On the Truth of the Scriptures*, intended to prepare the way for an English translation of them, in which he had made considerable progress. In 1381 he published *Sixteen Conclusions;* in the first of which he ventured to expose the grand article of transubstantiation. These conclusions being condemned by the chancellor of Oxford, Wickliff appealed to the king and parliament; but being deserted by his unsteady patron the duke of Lancaster, he was obliged to make a confession at Oxford; and by an order from the king was expelled the university. He now retired to his living of Lutterworth, where he finished his translation of the bible. This version, of which there are several manuscript copies in the libraries of the universities, British Museum, &c. is a very literal translation from the Latin vulgate. In 1383 he was suddenly struck with a palsy; a repetition of which put an end to his life in December 1384. He was buried in his own church, where his bones were suffered to rest in peace till the year 1428, when, by an order from the pope, they were taken up and burnt.—Besides a number of works that have been printed, he left a prodigious number of manuscripts; an accurate list of which may be seen in Bishop Tanner's *Bib. Brit. Hib.* Some of them are in the Bodleian Library, others in the British Museum, &c.

Wickliff was doubtless a very extraordinary man, considering the times in which he lived. His natural sagacity discovered the absurdities and impositions of the church of Rome, and he had the honesty and resolution to promulgate his opinions, which a little more support would probably have enabled him to establish: they were evidently the foundation of the subsequent reformation.

WICKLOW, a county of Ireland, in the province of Leinster; bounded on the north by the county of Dublin; on the east by the Irish sea; on the south by Wexford; and on the west by Kildare and Catherlough. It is 33 miles in length, 20 in breadth, and indifferently fruitful. It contains 54 parishes, and sends two members to parliament. See Wicklow, Supplement.

Wicklow, the capital of a county of the same name in Ireland; seated on the sea-side, with a narrow harbour, at the mouth of the river Leitrim, over which stands a rock, instead of a castle, surrounded by a strong wall, 24 miles south of Dublin. W. Long. 6. 7. N. Lat. 52. 55.

WIDGEON. See Anas, Ornithology *Index*.

WIDOW, a woman who has lost her husband.

WIFE, a married woman, or one joined with, and under the protection of, an husband. See Husband.

Isle of WIGHT, an island lying on the south coast of Hampshire, from which it is separated by a narrow channel. It is about 21 miles in length and 13 in breadth. It is nearly divided into equal parts by the river Mede or Cowes, which rising in the southern angle, enters at the northern, into the channel, opposite the mouth of Southampton bay. The south-coast is edged with very steep cliffs of chalk and freestone, hollowed into caverns in various parts. The west side is fenced with ridges of rocks, of which the most remarkable are those called, from their sharp extremities, the *Needles*. Between the island and the main are various sand-banks, especially off the eastern part, where is the safe road of St Helen's. Across the island, from east to west, runs a ridge of hills, forming a tract of fine downs, with a chalky or marly soil, which feed a great number of fine-fleeced sheep. Rabbits are also very plentiful here. To the north of this ridge the land is chiefly pasture: to the south of it is a rich arable country, producing great crops of corn. The variety of prospects which this island affords, its mild air, and the neat manner in which the fields are laid out, render it a very delightful spot. It is devoted almost solely to husbandry, and has no manufactory. It is one of the principal resources of the London market for unmalted barley. Among its products are to be reckoned a pure white pipe-clay, and a fine white crystalline sand; of the latter of which great quantities are exported for the use of the glass works in various parts. Its principal town is the

Will, William.

ment: that is called a *will* where lands or tenements are given; and when the disposition concerns goods and chattels alone, it is termed a *testament*. See TESTAMENT.

WILL-with-a-wisp, or *Jack with-a-lanthorn*, two popular names for the meteor called *ignis fatuus*. See LIGHT, N° 46.

WILLIAM *of* MALMSBURY, an history of considerable merit in the reign of King Stephen; but of whose life few particulars are known. According to Bale and Pits, he was surnamed *Somersetus*, from the county in which he was born. From his own preface to his second book *De Regibus Anglorum*, it appears that he was addicted to learning from his youth; that he applied himself to the study of logic, physic, ethics, and particularly to history. He retired to the Benedictine convent at Malmsbury, became a monk, and was made precentor and librarian; a situation which much favoured his intention of writing the history of this kingdom. In this monastery he spent the remainder of his life, and died in the year 1142. He is one of our most ancient and most faithful historians. His capital work is that intitled *De Regibus Anglorum*, in five books; with an Appendix, which he styles *Historiæ Novellæ*, in two more. It is a judicious collection of whatever he found on record relative to England, from the invasion of the Saxons to his own times.

WILLIAM of Newbury, so called from a monastery in Yorkshire, of which he was a member, wrote a history which begins at the Conquest and ends at the year 1197. His Latin style is preferred to that of Matthew Paris; and he is entitled to particular praise, for his honest regard to truth, in treating the fables of Jeffrey of Monmouth with the contempt they deserve; as well as for expressing his approbation of Henry II.'s design of reforming the clergy, by bringing them under the regulation of the secular power.

WILLIAM of Wykeham, bishop of Winchester, was born in the village of Wykeham, in the county of Southampton, in 1324. He was educated at Winchester and Oxford; and having continued near six years in the university, his patron Nicholas Wedal, governor of the province of Southampton, took him into his family, and appointed him his counsellor and secretary. He could not have made choice of a fitter person for that employment, no man in that age writing or speaking more politely than Wykeham. For this reason Edington, bishop of Winchester, lord high treasurer of the kingdom, appointed him his secretary three years after, and also recommended him to King Edward III. who took him into his service. Being skilled in geometry and architecture, he was appointed surveyor of the royal buildings, and also chief justice in eyre: he superintended the building of Windsor-castle. He was afterward chief secretary of state, a keeper of the privy seal; and in 1367 succeeded Edington in the see of Winchester. A little after he was appointed lord-high chancellor and president of the privy-council. That he might well discharge the several functions of his employments, both ecclesiastical and civil, he endeavoured on one hand, to regulate his own life according to the strictest maxims, and to promote such parish priets only as were able to give due instructions to their parishioners, and at the same time led exemplary lives: on the other hand, he did all in his power to cause justice to be impartially administered. In 1371 he resigned his chancellorship, and some time after the great seal. Edward returning to England, after having carried on a very successful war in France, found his exchequer in great disorder. The duke of Lancaster, one of his sons, at the head of several lords, having brought complaints against the clergy, who then enjoyed the chief places in the kingdom, the king removed them from their employments. But the laymen, who were raised to them, behaved so ill, that the king was forced to restore the ecclesiastics. The duke of Lancaster showed strong animosity to the clergy, and set every engine at work to ruin Wykeham. He impeached him of extortion, and of disguising things, and obliged him to appear at the King's-bench. He got such judges appointed as condemned him; and not satisfied with depriving him of all the temporalities of his bishopric, he advised Edward to banish him: but this prince rejected the proposal, and afterward restored to Wykeham all that he had been divested of. Richard II. was but 11 years old when Edward died: so that the duke of Lancaster had an easy opportunity of reviving the accusations against the bishop of Winchester; nevertheless Wykeham cleared himself. Then he founded two noble colleges, the one in Oxford, the other in Winchester. Whilst he was exerting his utmost endeavours to improve these two fine foundations, he was recalled to court, and in a manner forced to accept of the office of lord-high-chancellor in 1389.—Having excellently discharged the duties of that employment for three years, he obtained leave to resign it, foreseeing the disturbances that were going to break out. Being returned to his church, he finished his college, and built there so magnificent a cathedral, that it almost equals that of St Paul's in London. He laid out several sums in things advantageous to the public and to the poor; notwithstanding which, in 1397 he was in great danger; for he and some others were impeached of high-treason in open parliament: however, he was again fully cleared. From that time till his death he kept quiet in his diocese, and there employed himself in all the duties of a good prelate. He died in 1404, in the 81st year of his age.

WILLIAM, the name of several kings of England. See ENGLAND, N° 87—92, and BRITAIN, N° 302.

Fort-WILLIAM, a fortress in the Highlands of Scotland, erected in King William's reign, as was also a small town adjoining, called *Maryburgh*, in honour of his queen. It is situated in Inverness-shire, on a narrow arm of the sea called *Loch Eil*, which by the completion of the Caledonian canal, will be united to the Western sea. Fort-William is of a triangular form, having two bastions, and is capable of admitting a garrison of 800 men; but could not be defended against an attack, as it is commanded by several hills in the neighbourhood.

WILLIAM's Fort, is a factory of Asia belonging to the East India Company, seated on one of the branches of the river Ganges, in the kingdom of Bengal. The fort was first built in the shape of an irregular tetragon of brick and mortar; and the town has nothing regular in it, because every one built a house as he liked best, and for his own conveniency. The governor's house is within the fort, and is the best piece of architecture in these parts. Here there are also convenient lodgings for the factors and writers, with store-houses for the company's company's goods, and magazines for ammunition. About 50 yards from the fort is the church, which was originally built by the merchants. The town of *Calcutta* is contiguous, containing 500,000 inhabitants. It is governed by a mayor and aldermen, as most of the company's factories in the East Indies now are. In 1757 it was surprised by the nabob of Bengal, who took it, and put most of those that had made resistance into a place called the *Black-Hole*, where the greater number was suffocated. This nabob was afterwards killed, and another set up in his room, more friendly to the English; and the factory was re-established. E. Long. 86. 0. N. Lat. 22. 27. See CALCUTTA.

Sweet-William. See DIANTHUS, BOTANY *Index*.

WILLIAMSBURG, a town of North America, in Virginia, and formerly capital of that state. It is situated between two creeks; one falling into James and the other into York River. The distance of each landing place is about a mile from the town, which, with the disadvantage of not being able to bring up large vessels, and the want of enterprise in the inhabitants, has occasioned its decay. Here is a college, designed for the education of the Indians, but which, on account of their aversion to learning, never answered the purpose. It is 60 miles east of Richmond. W. Long. 76. 30. N. Lat. 37. 10.

WILLIAMSTADT, a sea-port town of Holland. It is a handsome strong place, and the harbour is well frequented. It was built by William prince of Orange in 1585; and in 1732 belonged to the stadtholder of Friesland. The river near which it is built is called *Butterfliet* or *Holland Diep*; and it is one of the bulwarks of the Dutch on the side of Brabant, where they always keep a garrison. This place made a gallant defence in 1793 against the French, who were obliged to raise the siege. It is 15 miles north-east of Bergen-op-Zoom, and 12 south-west of Dort. E. Long. 4. 30. N. Lat. 51. 39.

WILLIS, DR THOMAS, a celebrated English physician, was born at Great Bodwin, in Wiltshire, in 1621, and studied at Christ-church college, Oxford. When that city was garrisoned for the king, he, among other scholars, bore arms for his majesty, and devoted his leisure hours to the study of physic. The garrison of Oxford at length surrendering to the parliament, he applied himself to the practice of his profession; and soon rendered himself famous by his care and skill. He appropriated a room as an oratory for divine service according to the church of England, whither most of the loyalists in Oxford daily resorted. In 1660, he became Sedleian professor of natural philosophy, and the same year took the degree of doctor of physic. In 1664, he discovered the famous medicinal spring at Alstropp, near Brackley. He was one of the first members of the Royal Society, and soon made his name illustrious by his excellent writings. In 1666, after the fire of London, he removed to Westminster; and his practice became greater than that of any of the physicians his contemporaries. Soon after his settlement in London, his only son Thomas falling into a consumption, he sent him to Montpelier in France for the recovery of his health; and it proved successful. His wife also labouring under the same disorder, he offered to leave the town; but she, not suffering him to neglect the means

of providing for his family, died in 1670. He died at his house in St Martin's in 1675, and was buried near her in Westminster-abbey. Dr Willis was extremely modest and unambitious, and refused the honour of knighthood. He was remarkably pious: As he rose early in the morning, that he might be present at divine service, which he constantly frequented before he visited his patients, he procured prayers to be read beyond the accustomed times while he lived; and at his death settled a stipend of 20l. per annum to continue them. He was a liberal benefactor to the poor wherever he came, having from his early practice allotted part of his profits to charitable uses. He was exact and regular in all his hours: and though his table was the resort of most of the great men of London, yet he was remarkable for his plainness, and his being a man of little discourse, complaisance, or society; but he was justly admired for his deep insight into natural and experimental philosophy, anatomy, and chemistry; for his successful practice: and for the elegance and purity of his Latin style. He wrote, 1. A treatise in English, intitled *A plain and easy Method for preserving those that are well from the Infection of the Plague, and for curing such as are infected*. 2. Several Latin works, which were collected and printed at Amsterdam, in 1682, in 2 vols 4to.

WILLUGHBY, FRANCIS, a celebrated natural historian, was the only son of Sir Francis Willughby, knight. He was fond of study from his childhood, and held idleness in abhorrence; he being so great an economist with regard to his time, as not willingly to lose or misapply the least part of it, by which means he attained great skill in all branches of learning, and particularly in the mathematics. But to the history of animals, which was in a great measure neglected by his countrymen, he particularly applied himself; and for this purpose carefully read over what had been written on that subject by others. He then travelled several times over his native country; and afterwards into France, Spain, Italy, Germany, and the Low Countries, attended by his ingenious friend Mr John Ray. It is remarkable, that, notwithstanding the advantages of birth, fortune, and parts, he was as humble as any man of the meanest fortune; was sober, temperate, and chaste; scrupulously just; so true to his word and promise, that a man might venture his estate and life upon it; so faithful and constant to his friend, as never to desert him when fortune frowned upon him; and remarkably pious, patient, and submissive to the divine will. This is the character given of him by Mr Ray, whose veracity none will doubt. This ingenious and learned gentleman, died in 1672, at 37 years of age; having impaired his health by his application. He wrote, 1. *Ornithologiæ libri tres*, folio, which was afterwards translated into English, with an Appendix, by Mr Ray, in folio. 2. *Historiæ Piscium libri quatuor*, folio. 3. Letters of Francis Willughby, Esq. added to Philosophical Letters between the learned Mr Ray and several of his correspondents, published, in 8vo, by William Derham. 4. Several ingenious papers in the Philosophical Transactions.

WILMOT, JOHN, earl of Rochester, a great wit in the reign of Charles II. the son of Henry earl of Rochester, was born in 1648. He was taught grammar and classical learning at the free-school at Burford;

Wilmot. where he obtained a quick relish of the beauties of the Latin tongue, and afterwards became well versed in the authors of the Augustan age. In 1659, he was admitted a nobleman of Wadham college, where he obtained the degree of master of arts. He afterwards travelled through France and Italy; and at his return was made one of the gentlemen of the bedchamber to the king, and comptroller of Woodstock Park. In 1665, he went to sea, and was in the Revenge, commanded by Sir Thomas Tiddiman, when an attack was made on the port of Bergen in Norway: during the whole action he showed the greatest resolution, and gained a high reputation for courage; which he supported in a second expedition, but afterwards lost it in a private adventure with Lord Mulgrave.

Before the earl of Rochester travelled, he had indulged in the most disorderly and intemperate way of living; at his return, however, he seemed to have got the better of it entirely. But falling into the company of the courtiers, who continually practised these excesses, he became so sunk in debauchery, that he was for five years together so given up to drinking, that during all that time he was never cool enough to be master of himself. His violent love of pleasure, and his disposition to extravagant mirth, carried him to great excesses. The first involved him in sensuality, and the other led him into many adventures and ridiculous frolics. Once disguising himself so that he could not be known by his nearest friends, he set up in Tower-street for an Italian mountebank, and there dispersed his nostrums for some weeks. He often disguised himself as a porter, or as a beggar, sometimes to follow a mean amour; at other times, he would go about merely for diversion, in odd shapes; and acted his part so naturally, that he could not be known even by his friends. In short, by his constant indulgence in wine, women, and irregular frolics, he entirely wore out an excellent constitution before he was 30 years of age. In October 1679, when recovering from a violent disease, which ended in a consumption, he was visited by Dr Burnet, upon an intimation that such a visit would be agreeable to him. Dr Burnet published an account of his conferences with Lord Rochester; in which it appears, that though he had lived the life of a libertine and atheist, yet he died the death of a penitent Christian. His death happened in 1680; since which time his poems have been various times printed, both separately and together: but when once he obtained the character of a lewd and obscene writer, every thing in that strain was ascribed to him; and thus many pieces not of his writing have crept into the later editions of his works. The author of the Catalogue of Royal and Noble Authors says, he was "a man whom the Muses were fond to inspire, and ashamed to avow, and who practised without the least reserve that secret which can make verses more read for their defects than their merits. Lord Rochester's Poems have much more obscenity than wit, more wit than poetry, and more poetry than politeness." His writings, besides those already mentioned, are, A Satire against Mankind; Nothing, a poem; Valentinian, a tragedy; Fifty four Letters to Henry Saville, and others; Seven more to his wife and Son: a Letter on his deathbed to Dr Burnet. He also left behind him several other papers, and a History of the Intrigues of the Court of Charles II.; but his mother, a very devout lady, ordered all his papers to be burned.

WILSON, FLORENCE, known in the republic of letters by the name of *Florentius Volusinus*, was born at Elgin in the shire of Murray in Scotland, and educated in the university of Aberdeen. Travelling to England with an intention to improve his fortune, he had the felicity to be introduced to Cardinal Wolsey, who appointed him tutor to one of his nephews. In that capacity he went to Paris, and continued there till the Cardinal's death. During his residence in that city he became acquainted with the learned Cardinal Bellai, archbishop of Paris, who allowed him a pension, and meant to have appointed him royal professor of the Greek and Latin languages in the university of Paris: but Bellai being disgraced, Wilson's prospects faded with the fortunes of his patron, whom nevertheless he attended on his journey to Rome. Wilson was taken ill at Avignon, and the cardinal proceeded without him. After his recovery, he paid a visit to the celebrated Cardinal Sabolet, the Mecænas of his time, who was also bishop of Carpentras, where he then resided. The cardinal was so charmed with his erudition, that he appointed him professor of the learned languages, with a stipend of 100 pistoles per annum.

During his residence at Carpentras, he wrote his celebrated treatise *De Animi Tranquillitate*. Mackenzie says that he afterwards taught philosophy in Italy; and that, being at length desirous of returning to Scotland, he began his journey homeward, was taken ill at Vienne in Dauphiny, and died there in the year 1547. He was generally esteemed an accomplished linguist, an admirable philosopher, and an excellent Latin poet. He wrote, beside the above treatise, 1. *Poemata*, London 1619, 4to. 2. *Commentatio quædam theologica in aphorismos dissecta, per Sebast. Gryph.* 3. *Philosophiæ Aristot. Synopsis*, lib. iv.

WILSON, *Thomas*, lord bishop of Sodor and Man, was born in 1663, at Burton, in the county of Chester. He received the rudiments of his education at the county town, and from thence was removed to the university of Dublin. His allowance at the university was 20l. a-year; a sum, small as it may now appear, which was in those days sufficient for a sober youth in so cheap a country as Ireland.

His first intention was to have applied to the study of physic; but from this he was diverted by Archdeacon Hewetson, by whose advice he dedicated himself to the church. He continued at college till the year 1686, when, on the 29th of June, he was ordained deacon.

The exact time of Mr Wilson's leaving Dublin is not known: but on account of the political and religious disputes of those days, it was sooner than he intended. On the 10th of December, in the same year, he was licensed to the curacy of New Church in Winwick, of which Dr Sherlock, his maternal uncle, was rector. His stipend was no more than 30l. a-year; but being an excellent economist, and having the advantage of living with his uncle, this small income was not only sufficient to supply his own wants, but it enabled him to supply the wants of others; and for this purpose he set apart one-tenth of his income. In 1692 he was appointed domestic chaplain to William earl of Derby, and tutor to his son James Lord Strange, with a salary of

Wilson.

of 30l. a-year. He was soon after elected master of the alms-house at Latham, which brought him in 20l. a-year more. Having now an income far beyond his expectations, or his wishes, except as it increased his ability to do good, he set apart one-fifth of his income for pious uses, and particularly for the poor. In short, as his income increased, he increased the portion of it which was allotted to the purposes of charity. At first he set apart a tenth, then a fifth, afterwards a third, and lastly, when he became a bishop, he dedicated the full half of his revenues to pious and charitable uses.

He had not been long in the service of Lord Derby, before he was offered the valuable living of Buddesworth in Yorkshire; which he refused to accept, as being inconsistent with the resolves of his conscience against non-residence, Lord Derby choosing still to retain him as chaplain and tutor to his son. In 1697 he was promoted, not without some degree of compulsion on the part of his patron, to the bishopric of the Isle of Man; a preferment which he held 58 years. In 1698 he married Mary, daughter of Thomas Patten, Esq. of Warrington. By this lady who survived her marriage above six years, he had four children; none of whom survived him, except the late Dr Wilson, prebendary of Westminster.

"The annual receipts of the bishopric (says the author of his memoirs) did not exceed 300l. in money. Some necessaries in his house, as spices, sugar, wine, books, &c. must be paid for with money; distressed or shipwrecked mariners, and some other poor objects, required to be relieved with money; but the poor of the island were fed and clothed, and the house in general supplied from his demesnes, by exchange, without money. The poor, who could weave or spin, found the best market at Bishop's-court, where they bartered the produce of their labour for corn. Taylors and shoemakers were kept in the house constantly employed, to make into garments or shoes that cloth or leather which his corn had purchased; and the aged and infirm were supplied according to their several wants. Mr Moore of Douglas informed the editor, that he was once witness to a pleasing and singular instance of the Bishop's attention to some aged poor of the island. As he was distributing spectacles to some whose eyesight failed them, Mr Moore expressed his surprise, as he well knew not one of them could read a letter. "No matter (said the Bishop with a smile), they will find use enough for them; these spectacles will help them to thread a needle, to mend their clothes, or if need be, to keep themselves free from vermin."

So great was the bishop's attachment to his flock, that no temptation could seduce him from their service. He more than once refused the offer of an English bishopric. There is an anecdote of his lordship and Cardinal Fleury, which does great credit to them both. The cardinal wanted much to see him, and sent over on purpose to inquire after his health, his age, and the date of his consecration, as they were the two oldest bishops, and he believed the poorest, in Europe; at the same time inviting him to France. The bishop sent the cardinal an answer, which gave him so high an opinion of him, that the cardinal obtained an order that no French privateer should ravage the isle of Man.

This good prelate lived till the year 1755, dying at the advanced age of 93. His works have lately been published in 2 vols. 4to.

Wilson ‖ Winchelsea.

WILTON, a market town in Wiltshire, three miles west of Salisbury. It was once so considerable as to give title to the county. It had formerly 12 churches; and Odo, brother-in-law to William I. was bishop of Wilton. Only one now remains, and its inhabitants in 1811 amounted to 1963. It sends members to parliament, and is the place where the knights of the shire are chosen. It has a great manufactory of carpets, which are brought to high perfection. Wilton is famous for Lord Pembroke's seat, so well known through Europe for its containing a grand assemblage of the productions of the greatest and most ancient masters in painting and sculpture.—Two fairs are held here anually.

WILTSHIRE, a county of England, bounded on the west by Somersetshire, on the east by Berkshire and Hampshire, on the north by Gloucestershire, and on the south by Dorsetshire and part of Hampshire. The length amounts to 39 miles; its breadth to 30; and its circumference to 140. It contains 29 hundreds, 23 market-towns, 304 parishes, and in 1811 had 193,828 inhabitants. Besides two members for the shire, and two for the city of Salisbury, each of the following towns sends two members to parliament, viz. Wilton, Downton, Hindon, Heytesbury, Westbury, Calne, Devizes, Chippanham, Malmsbury, Cricklade, Great Bedwin, Ludgershall, Old Sarum, Wooton-Basset, Marlborough.

The air of this county is very healthy, not only in the more low and level parts, but also on the hills. The soil of the vales is very rich, and produces corn and grass in great plenty. The beautiful downs in the south yield the finest pasture for sheep, with which they are overspread. The greatest disadvantage the county labours under is want of fuel, as there is no coal-pits, and but little wood. This county is noted for great quantities of very fine cheese, and for its manufacture of broad cloth, to which it was invited by the great plenty and fineness of its wool. It is watered by the rivers Isis, Kennet, Upper and Lower Avon, Willy, Burne, and Nadder, which are well stored with fish. See Wiltshire, Supplement.

WINCHELSEA, a town in Sussex, which has no market, but has one fair on May 14th for cattle and pedlars ware. It was an ancient place, at least the old town, which was swallowed up by the ocean in 1250. It is now dwindled to a mean place, though it retains its privileges, and sends two members to parliament. It is seated on a rocky cliff, on an inlet of the sea; and had a haven, now choked up. It had 18 parish-churches, now reduced to one. The market-house is in the midst of the town, from whence run four paved streets, at the end of which are four ways, which had formerly buildings on each side for a considerable distance. It is 71 miles south-east of London. It is governed by a mayor and jurats, though it had but 652 inhabitants in 1811. Three of the gates are still standing, but much decayed. E. Long. 0. 44. N. Lat. 50. 58.

Winchelsea, *Anne Countess of*, a lady of excellent genius, especially in poetry, was maid of honour to the duchess of York, second wife to King James II. and was afterwards married to Heneage, second son of the earl of Winchelsea. One of the most considerable of the countess of Winchelsea's poems was that on the

Spleen. A collection of her poems was printed at London in 1713, containing a tragedy never acted, intitled *Aristomenes*. The countess died in 1720 without issue, as her husband did in 1706.

WINCHESTER, the capital of the county of Hampshire in England. It is a very ancient city, supposed to have been built several centuries before Christ. The Romans called it *Venta Belgarum*, the Britons *Caer Givent*, and the Saxons *Wittanceaster*; whence came the present name. It stands upon the river Itchin, in a bottom surrounded with chalky hills; and is generally allowed to have been a considerable place in the time of the Romans. Some of the first converts to Christianity are supposed to have lived here. In the castle, near the west gate, many of the Saxon kings anciently kept their court. The cathedral was founded by Kenegulfe, a king of the Mercians; but there were many Christians, and places for their worship here, long before that period. It is a large pile, and has a venerable look, but is not very elegant. Besides the tombs, there are many curious pieces of workmanship in it; the chief of which are, 1. The font, erected in the time of the Saxons. 2. Copper statues of James I. and Charles I. 3. The bishop's throne. 4. The stalls of the dean and prebendaries. 5. The ascent to the choir and altar. 6. The pavement inlaid with marble of diverse colours, in various figures. 7. The altar-piece, reckoned the noblest in England. 8. The paintings in the windows, especially the great east window. At the hospital of the Holy Cross, every traveller that knocks at the door may claim a manchet of white bread and a cup of beer; of which a great quantity is provided every day for that purpose. This hospital was intended for the maintenance of a master and 30 pensioner, but only 14 are now maintained in it; and the master enjoys a revenue of 800l. a-year. This city is about a mile and a half in compass, and almost surrounded with a wall of flint; has six gates, large suburbs, broad clean streets; but the private houses are in general but ordinary, many of them being very old. The city is interspersed with a great many gardens, which contribute to its beauty and healthiness. The corporation consists of a mayor, high-steward, recorder, aldermen, two coroners, two bailiffs, 24 common-council men, a town-clerk, four constables, and four serjeants at mace; and the city gives title of *marquis* to the duke of Bolton. A Roman highway leads from hence to Alton; and went formerly, as it is thought, from thence to London. The charming downs in the neighbourhood contribute greatly to the health and pleasure of the inhabitants. The river Itchin is navigable for barges from hence to Southampton. The population in 1811 amounted to 6705 persons. W. Long. 1. 16. N. Lat. 50. 57.

WINCKLEMAN, Abbe John, was born at Stendall, in the old Marche of Brandenburg, in 1718. His father was a shoemaker. This wonderful man, to all appearance destined by his birth to superintend a little school in an obscure town of Germany, raised himself to the office of president of antiquities in the Vatican. After having been seven years professor in the college of Seehausen near Salswedel, he went into Saxony, where he resided seven years more, and was librarian to Count Bunau at Nethenitz. When he left this place, 1754, he went to Dresden, where he formed an acquaintance with the ablest artists, and particularly with M. Oeser, an excellent painter, and one of the best draughtsmen of the age. In that year he abjured Lutheranism, and embraced the Roman Catholic religion. In September 1755, he set out for Italy, and arrived at Rome in December following. His principal object was to see the Vatican library, and to examine the ruins of Herculaneum.

Mr Winckleman carried with him into Italy a sense of beauty and art, which led him instantly to admire the masterpieces of the Vatican, and with which he began to study them. He soon increased his knowledge; and it was not till after he had thus purified his taste and conceived an idea of ideal beauty, which led him into the greatest secrets of art, that he began to think of the explanation of other monuments, in which his great learning could not fail to distinguish him. His erudition enabled him to fill up his principal plan of writing the "History of Art." In 1756, he planned his "Restoration of Ancient Statues," and a larger work on the Taste of the Greek Artists; and designed an account of the galleries of Rome and Italy, beginning with a volume on the Belvidere statues, in the manner of Richardson, who, he says, only ran over Rome. He also intended a history of the corruption of taste in art, the restoration of statues, and an illustration of the obscure points of mythology. All these different essays led him to his "History of Art," and his "Monumenti Inediti." It must, however, be confessed, that the first of these works has not all the clearness and precision that might be expected in its general plan and division of its parts and objects; but it has enlarged and extended the ideas both of antiquaries and collectors. The description of the gems and sulphurs of the Stosch cabinet contributed not a little to extend Mr Winckleman's knowledge. Few persons have opportunities of contemplating such vast collections. The engravings of Lippet and Count Caylus are all that many can arrive at. Mr Winckleman's Monumenti Inediti, of which he had begun the third volume 1767, seem to have secured him the esteem of antiquaries. Had he lived, we should have had a work long wished for; a complete collection of the bas-reliefs discovered from the time of Bartoli to the present, the greater part of which are in the possession of Cardinal Albani.

When Cardinal Albani succeeded to the place of librarian of the Vatican, he endeavoured to get a place for the Hebrew language for Winckleman, who refused a canonry. because he would not take the tonsure. The elector of Saxony gave him, 1761, unsolicited, the place of Counsellor Richter, the direction of the royal cabinet of medals and antiquities at Dresden. Upon the death of the abbé Venuti, 1762, he was appointed president of the antiquities of the apostolic-chamber, with power over all discoveries and exportations of antiquities and pictures. This is a post of honour, with an income of 160 scudi per annum. He had a prospect of the place of president of antiquities in the Vatican going to be created at 16 scudi per month, and was named corresponding member of the Academy of Inscriptions. The king of Prussia offered him, by Col. Quintus Icilius, the place of librarian and director of his cabinet of medals and antiquities, void by the death of M. Gautier de la Croze, with a handsome appointment. He made no scruple of accepting the offer; but when it came to the pope's ears, he added an appointment out of his own purse, and kept him at Rome.

In

In April 1786, he left Rome to go with M. Cavaceppi over Germany and Switzerland. When he came to Vienna, he was so pleased with the reception he met with, that he made a longer stay there than he had intended. But, being suddenly seized with a secret uneasiness and extraordinary desire to return to Rome, he set out for Italy, putting off his visits to his friends in Germany to a future opportunity. As he passed through Trieste, he was assassinated, June 8. 1786, by a wretch named Arcangeli, a native of Campiglio, a town in the territory of Pistoia, with whom he had made an acquaintance on the road. This miscreant had been condemned for a robbery to work in fetters four years, and then to be banished the Austrian territories, on an oath never to return. He had obtained a mitigation of one of his sentences, and retired to Venice; but, changing his quarters backwards and forwards, he was so reduced in circumstances that he at length took up his lodgings at the inn to which the Abbé happened to come. Arcangeli paid such assiduous court to him, that he entirely gained his confidence; and having been favoured with a sight of the valuable presents which he had received at Vienna, formed a design to murder and rob him. He bought a new sharp knife on purpose; and as the Abbé (who had in the most friendly manner invited him to Rome) was sitting down in his chair, early in the morning, he threw a rope over his head, and before he could disengage himself, stabbed him in five different places. The Abbé had still strength to get down to the ground floor, and call for help; and being laid on a bed in the midst of the most violent pain, he had composure sufficient to receive the last sacraments, and to make his will, in which he appointed Cardinal Alexander Albani his residuary legatee, and expired in the afternoon. The murderer was soon after apprehended; and executed on the wheel opposite the inn, June 26.

Abbé Winckleman was a middle-sized man; he had a very low forehead, sharp nose, and little black hollow eyes, which gave him an aspect rather gloomy than otherwise. If he had any thing graceful in his physiognomy, it was his mouth. A fiery and impetuous disposition often threw him into extremes. Naturally enthusiastic, he often indulged an extravagant imagination; but as he possessed a strong and solid judgment, he knew how to give things a just and intrinsic value. In consequence of this turn of mind, as well as a neglected education, a cautious reserve was a quality he little knew. If he was bold in his decisions as an author, he was still more so in his conversation, and has often made his friends tremble for his temerity. If ever man knew what friendship was, that man was Mr Winckleman, who regularly practised all his duties; and for this reason he could boast of having friends among persons of every rank and condition.

WIND is a sensible agitation of the atmosphere, occasioned by a quantity of air flowing from one place to another. See METEOROLOGY.

Hot WINDS. See SAMIEL.

WIND-Flower. See ANEMONY, BOTANY *Index*.

WIND-Mill, a kind of mill, the internal parts of which are much the same with those of a water mill: from which, however, it differs, in being moved by the impulse of the wind upon its sails or vanes, which are to be considered as a wheel in axis. See MECHANICS *Index*.

WIND Gage. See *Wind-GAGE*.

WIND-Galls. See FARRIERY *Index*.

WIND-Gun. See *AIR GUN*, under *SCIENCE, Amusements of*.

Instruments for measuring the strength, velocity, &c. *of the WIND*. See *Wind-GAGE*, ANEMOMETER and ANEMOSCOPE.

WIND-Hatch, in mining, a term used to express the place at which the ore is taken out of the mines.

WIND-Shock, a name given by our farmers to a distemper to which fruit trees, and sometimes timber trees, are subject. It is a sort of bruise and shiver throughout the whole substance of the tree; but the bark being often not affected by it, it is not seen on the outside, while the inside is twisted round, and greatly injured. It is by some supposed to be occasioned by high winds; but others attribute it to lightning. Those trees are most usually affected by it whose boughs grow more out on one side than on the other. The best way of preventing this in valuable trees, is to take care in the plantation that they are sheltered well, and to cut them frequently in a regular manner while young.

WIND-Taught, in sea language, denotes the same as stiff in the wind. Too much rigging, high masts, or any thing catching or holding wind aloft, is said to hold a ship wind-taught; by which they mean, that she stoops too much in her sailing in a stiff gale of wind. Again, when a ship rides in a main stress of wind and weather, they strike down her top masts, and bring her yards down, which else would hold too much wind, or be too much distended and wind-taught.

WIND-Sails, a sort of wide tube or funnel of canvas, employed to convey a stream of fresh air downward into the lower apartments of a ship.

This machine is usually extended by large hoops situated in different parts of its height. It is let down perpendicularly through the hatches, being expanded at the lower end like the base of a cone; and having its upper side open on the side which is placed to windward, so as to receive the full current of wind; which entering the cavity, fills the tube, and rushes downwards into the lower regions of the ship. There are generally three or four of these in our capital ships of war, which, together with the ventilators, contribute greatly to preserve the health of the crew.

WINDAGE *of a GUN*, is the difference between the diameter of the bore and the diameter of the ball.

WINDLASS, a machine used for raising huge weights, as guns, stones, anchors, &c.

It is very simple, consisting only of an axis or roller, supported horizontally at the two ends by two pieces of wood and a pulley; the two pieces of wood meet at top, being placed diagonally so as to prop each other; the axis or roller goes through the two pieces, and turns in them. The pulley is fastened at top where the pieces join. Lastly, there are two staves or handspikes which go through the roller, whereby it is turned, and the rope which comes over the pulley is wound off and on the same.

WINDLASS, in a ship, is an instrument in small ships, placed upon the deck, just abaft the fore mast. It is made of a piece of timber six or eight feet square, in form

Windlass ‖ Wine.

form of an axletree, whose length is placed horizontally upon two pieces of wood at the ends thereof, and upon which it is turned about by the help of hand-spikes put into holes made for that purpose. This instrument serves for weighing anchors, or hoisting of any weight in or out of the ship, and will purchase much more than any capstan, and that without any danger to those that heave; for if in heaving the windlass about, any of the handspikes should happen to break, the windlass would pall of itself.

WINDOW, an aperture or open place in the wall of a house to let in the light. See ARCHITECTURE, N° 78.

The word is Welch, *uynt dor*, signifying the passage for the wind. Window is yet provincially denominated *windor* in Lancashire; i. e. *wind-door*, or the passage for air, as that for people was peculiarly called the *door*.

Before the use of glass became general, which was not till towards the end of the 12th century, the windows in Britain seem generally to have been composed of paper. Properly prepared with oil, this forms no contemptible defence against the intrusions of the weather, and makes no incompetent opening for the admission of the light. It is still used by our architects for the temporary windows of unfinished houses, and not unfrequently for the regular ones of our work shops. But some of the principal buildings we may reasonably suppose to have been windowed in a superior manner. They could, however, be furnished merely with lattices of wood or sheets of linen, as these two remained the only furniture of our cathedrals nearly to the eighth century; and the lattices continued in some of the meaner towns of Lancashire to the 18th; and in many districts of Wales, and many of the adjoining parts of England, are in use even to the present moment. These seem all to have been fixed in frames that were called *capsamenta*, and now therefore *casements* in Wales and Lancashire.

WINDSOR, a borough town of Berkshire, 22 miles west of London, most remarkable for the magnificent royal palace or castle situated there on an eminence, which commands the adjacent country for many miles, the river Thames running at the foot of the hill. The knights of the Garter are installed in the royal chapel here. It sends two members to parliament. The number of inhabitants in 1811 was 6155. W. Long. 0. 36. N. Lat. 51. 30.

WINDWARD, in the sea language, denotes any thing towards that point from whence the wind blows, in respect of a ship: thus windward-tide, is the tide which runs against the wind.

WINE, an agreeable spirituous liquor, produced by fermentation from those vegetable substances that contain saccharine matter. A very great number of vegetable substances may be made to afford wine, as grapes, currants, mulberries, elders, cherries, apples, pulse, beans, pease, turnips, radishes, and even grass itself. Hence, under the class of wines or vinous liquors, come not only wines, absolutely so called, but also ale, cyder, &c.

Chaptal's Chemistry, part iv. sect. v. chap. 6.

1 Method of making wine.

Wine, however, is in a more particular manner appropriated to the liquor drawn from the fruit of the vine. The process of making wine is as follows: When the grapes are ripe, and the saccharine principle is developed, they are then pressed, and the juice which flows out is received in vessels of a proper capacity, in which the fermentation appears, and proceeds in the following manner: At the end of several days, and frequently after a few hours, according to the heat of the atmosphere, the nature of the grapes, the quantity of the liquid, and temperature of the place in which the operation is performed, a movement is produced in the liquor, which continually increases; the volume of the fluid increases; it becomes turbid and oily; carbonic acid is disengaged, which fills all the unoccupied part of the vessel, and the temperature rises to the 72.5th degree. At the end of several days these tumultuous motions subside, the mass falls, the liquid becomes clearer, and is found to be less saccharine, more odorant, and of a red colour, from the reaction of the ardent spirit upon the colouring matter of the pellicle of the grape.

The wine is usually taken out of the fermenting vessels at the period when all the phenomena of fermentation have subsided. When the mass is settled, the colour of the liquor is well developed, when it has become clear, and its heat has disappeared; it is put into casks, where, by a second insensible fermentation, the wine is clarified, its principles combine more perfectly together, and its taste and smell become more and more developed. If this fermentation be stopped or suffocated, the gaseous principles are retained, and the wine is brisker, and more of the nature of must.

It appears, from the interesting experiments of the Marquis de Bullion, that the vinous fermentation does not take place unless tartar be present.

1 Causes of imperfect fermentation.

The causes of an imperfect fermentation are the following: 1. If the heat be too little, the fermentation languishes, the saccharine and oily matters are not sufficiently elaborated, and the wine is unctuous and sweet. 2. If the saccharine body be not sufficiently abundant, as happens in rainy seasons, the wine is weak, and the mucilage which predominates, causes it to become sour by its decomposition. 3. If the juice be too watery, concentrated and boiling must is added. 4. If the saccharine principle be not sufficiently abundant, the defect may be remedied by the addition of sugar. Macquer has proved that excellent wine may be made of verjuice and sugar; and M. de Bullion has made wine at Bellejames, with the verjuice of his vine rows and moist sugar.

There have been many disputes to determine whether grapes should be pressed with the stalks or without. This depends on the nature of the fruit. When they are highly charged with saccharine and mucilaginous matter, the stalk corrects the insipidity of the wine by its bitter principle: but when, on the contrary, the juice is not too sweet, the stalk renders it drier, and very rough.

Colouring matter of wine.

The colouring principle of wine is of a resinous nature, and is contained in the pellicle of the grape; and the fluid is not coloured until the wine is formed; for until then there is nothing which can dissolve it: and hence it is that white wine may be made of red grapes, when the juice of the grape is expressed, and the husk thrown away. If wine be evaporated, the colouring principle remains in the residue, and may be extracted by spirit of wine. Old wines lose their colour; a pellicle being precipitated, which is either deposited on the sides of the bottles, or falls to the bottom. If wine be exposed to the heat of the sun during the summer, the colouring matter is detached in a pellicle, which falls to the bottom: when the vessel is opened, the discolouring

is

Wine.

is more speedy, and it is effected in two or three days during the summer. The wine thus deprived of its colour is not perceptibly weakened.

4 Vinous fermentation explained.

The vinous fermentation has been examined with great accuracy by M. Lavoisier. According to him, the vegetable juice of which wine is to be made consists of oxygen, hydrogen, and carbone, combined with one another in different proportions, so as to form chiefly water and sugar. The fermentation produces a separation of the elements, and a new combination of them; a quantity of the oxygen and carbone combine and fly off in the state of carbonic acid; part of the carbone, oxygen, and hydrogen, combine first with each other, and then all together, to form alcohol; another part forms acetous acid; the water still remains, and a residuum falls to the bottom composed of the three elements combined in other proportions.

5 Ingredients of different wines.

The different kinds of wines produced in Europe and other parts of the world are many; the principal of them and their qualities are well known: a catalogue of them would serve no purpose here. We shall, however, subjoin a table of the quantities of the ingredients of the principal kinds from Neumann's Chemistry.

A quart of	Highly rectified Spirit.			Thick, oily, unctuous, resinous matter.			Gummy and tartarous matter.			Water.			
	oz.	dr.	gr.	oz	dr.	gr.	oz	dr.	gr.	lb.	oz.	dr.	gr
Aland	1	6	00	3	2	00	1	5	00	2	5	3	00
Alicant	3	6	00	6	0	20	0	1	40	2	2	6	00
Burgundy	2	2	00	0	4	00	1	1	40	2	9	0	20
Carcassone	2	6	00	0	4	10	0	1	20	2	8	4	30
Champagne	2	5	00	0	6	40	0	1	00	2	8	3	00
French	3	0	00	0	6	40	0	1	00	2	8	0	20
Frontignac	3	0	00	3	4	00	0	5	20	2	4	6	30
Vin Grave	2	0	00	0	6	00	0	2	00	2	9	0	00
Hermitage	2	7	00	1	2	00	0	1	40	2	7	5	20
Madeira	2	3	00	3	2	00	2	0	00	2	4	3	00
Malmsey	4	0	00	4	3	00	2	3	00	2	1	2	00
Vino de Monte Pulciano	2	6	00	0	3	00	0	2	40	2	8	0	20
Moselle	2	2	00	0	4	20	0	1	30	2	9	0	10
Muscadine	3	0	00	2	4	00	1	0	00	2	5	4	00
Neufschatel	3	2	00	4	0	00	1	7	00	2	2	7	00
Palm Sec	2	3	00	2	4	00	4	4	00	2	2	5	00
Pontac	2	0	00	0	5	20	0	2	00	2	9	0	40
Old Rhenish	2	0	00	1	0	00	0	2	20	2	8	5	40
Rhenish	2	2	00	0	3	20	0	1	34	2	9	1	06
Salamanca	3	0	00	3	4	00	2	0	00	2	3	4	00
Sherry	3	0	00	6	0	00	2	2	00	2	0	6	00
Spanish	1	2	00	2	4	00	9	4	00	1	10	6	00
Vino Tinto	3	0	00	6	4	00	1	6	00	2	0	6	00
Tokay	2	2	00	4	3	00	5	0	00	2	0	3	00
Tyrol red wine	1	4	00	1	2	00	0	4	00	2	8	6	00
Red wine	1	6	00	0	4	40	0	2	00	2	9	3	20
White	2	0	00	0	7	00	0	3	00	2	7	0	00

The colour of wine is frequently artificial; a deep red is almost always the effect of artificial additions, as of the red woods, elder berries, bilberries, &c. In France no secret is made of these practices, the colouring matters being publicly thrown out after they have been used.

6 Adulteration of wine.

It is well known to be a common practice among wine-coopers, innkeepers, and other dealers in wines, to adulterate bad wine in order to conceal its defects: if, for instance, the wine be sour, they throw into it a quantity of sugar of lead, which entirely takes away the sour taste. For similar purposes alum is often mixed with wine. Such substances, however, are well known to be extremely pernicious to the human constitution; it becomes of importance therefore to be able to detect them whenever they happen to be contained in wine. Several chemists who have turned their attention to this subject, have furnished us with tests for this purpose.

7 To detect lead in wine. *Watson's Chemical Essays*, vol. iii. p. 371.

To discover lead dissolved in wine, boil together in a pint of water an ounce of quicklime and half an ounce of flour of brimstone; and when the liquor, which will be of a yellow colour, is cold, pour it into a bottle, and cork it up for use. A few drops of this liquor being dropt into a glass of wine or cyder containing *lead*, will change the whole into a colour more or less *brown*, according to the quantity of lead which it contains. If the wine be wholly free from lead, it will be rendered turbid by the liquor, but the colour will be rather a dirty white than a black brown.

By this test, however, iron is also precipitated when dissolved in wine, and is apt to be taken for lead; a mistake which has ruined several honest merchants. The following test is therefore preferable, as not liable to the same inconvenience.

8 Another method.

Take equal parts of calcined oyster-shells and crude sulphur in fine powder, and put them in a crucible, which put into a fire, and raise the heat suddenly till it has been exposed to a white heat for 15 minutes. Then take it out, let it cool, beat the ingredients to powder, and put them into a well corked bottle. To prepare the test liquor, take 20 grains of this powder together with 120 grains of cream of tartar, and put them into a strong bottle, fill it up with water, boil it for an hour, and let it cool. Cork the bottle immediately, and shake it from time to time. After some hours repose, decant off the clear liquor into an ounce vial, having first put 22 drops of muriatic acid into each vial. Cork these vials accurately with a little wax mixed up with a little turpentine. One part of this liquor, mixed with three parts of suspected wine, will discover the presence of the smallest quantity of lead or copper, by a very sensible black precipitate, and of arsenic by an orange precipitate: but will have no effect on iron, if there be any; the presence of which, however, may be ascertained by adding a little potash, which will turn the liquor black if there be any iron. Pure wine remains limpid after the addition of this liquor*.

* *Journal de Physique*, October 1791.

9 State of lead in wine.

As this subject is of importance, we shall add M. Fourcroy's observations on the state in which lead exists in wine, and on the methods of discovering its presence: "Of the different principles which compose wine, there was no doubt (says he) but that acids were the only ones which were capable of dissolving oxide (*calx*) of lead. But was it the tartareous acid always contained in larger or smaller quantity in wine, or the acetous acid developed in those which have become sharp, and which there is a greater temptation to sweeten? Experience

Wine. rience had proved to me that the acidulous tartrate of potash, or the cream of tartar, takes oxide of lead from the acetous acid, and a precipitate of tartrate of lead is formed; the pure tartareous acid prepared in Scheele's method produces the same effect. In order to understand how the sharp wine which contains these two acids can hold the oxide of lead in solution, I made the experiments which gave me the following results: 1. The acidulous tartrate (*crem. tart.*) has no sensible action upon the oxides of lead. 2. The pure tartareous acid has a slight action upon the oxides, and forms on their surface a little tartrate of lead (*tartarised lead*), in a white powder. 3. Wine which only contains the tartareous acidule, would not have any action upon the semi-vitrous oxide of lead or litharge. 4. Sharp wine which we attempt to sweeten by this oxide of lead, acts first upon it by the acetous acid it contains. 5. When this acetite of lead is formed, the tartareous acid precipitates it in the form of tartrite of lead; this is proved by the precipitate which the solution of the acetite of lead or sugar of lead forms in the wine. 6. But the acetous acid, if it be in large enough quantity, redissolves the tartrate of lead in the wine just as distilled water would. Bergman has pointed out this solution of tartrite of lead in acetous acid for distinguishing the tartareous salt from the sulphate of lead (*vitriol of lead*). 7. As this solution of tartrate of lead in the acetous acid is much quicker, and more easy in sharp wines than in distilled water and vinegar, it is probable that the cause of this difference depends upon the citric and malic acids which I have found in wine, and which I shall take notice of again on another occasion. 8. Litharged wine then, or wine sweetened with lead, contains tartrite dissolved in the acetous acid, and perhaps at the same time in the malic and citric acids.

10 It forms an aceto-tartrite of lead.

"It was necessary afterwards to know the properties of this combination. What experience has taught me is as follows: I particularly examined the tartrite of lead and its solution in acetous acid. The tartrite of lead is scarcely at all soluble in water; it is in the form of powder, or of small white grains which have no sensible taste; when it is dissolved in vinegar, the vinegar is softened, its sharpness is diminished remarkably, and the solution takes a slight sweetish taste, much less strong than that of the pure acetite of lead. This taste proves that the union of the tartrite of lead with vinegar is not only a solution like that of salt in water, by which the properties of the salt are not changed, but a combination which gives occasion to new properties. It is a kind of a triple salt, different from those we have hitherto known, formed of two acids and of one base; whereas the other triple salts described hitherto are composed of one acid and two bases. I name this new triple salt *aceto-tartrite of lead*. The acetous acid adheres to it more than water in a common solution: what is remarkable in this combination is, that the two acids appear to adhere to the base with an equal force, although they have a different attraction for it: nothing is necessary to produce this equilibrium, but to unite first the oxide of lead with the acid to which it adheres the most strongly, and afterwards to put this first compound in contact with the weaker acid.

11 Other methods of detecting this salt.

"It was necessary, in order to discover easy and certain methods of ascertaining the presence of lead in wine, to examine with care the properties and phenomena of the decompositions of the aceto-tartrite of lead. Fixed alkalies and ammoniac (*volatile alkali*) precipitate from this salt an oxide of lead, which is of a grayish white colour; but as they occasion a precipitate in pure wine, they cannot be of any use. The sulphuric (*vitriolic*) acid decomposes the aceto-tartrite of lead, and forms with it instantly sulphate of lead; which being very little soluble, and very heavy, is precipitated. The oxalic, or pure saccharine acid, and the acidulous oxalate, or the salt of sorrel of the shops, likewise decompose this salt, and take from it the lead. The oxalate of lead is precipitated in great abundance: these two acids, the suphuric and oxalic acids, not producing any precipitate in pure wine, are very proper to show the presence of lead in wine. The sulphate and oxalate of lead, when they are precipitated from wine, are coloured, whereas they are very white when they are formed in distilled water; but their red or brown colour does not prevent us from discovering them by a very simple method. If the precipitates be collected with care, and are cautiously heated upon a coal with a blow-pipe, they smoke, become white, exhale vapours, pass successively through the states of the red and yellow oxides of lead, and at length are reduced into metallic globules at the instant they are perceived to be agitated by a very evident effervescence: if we cease to blow at this instant, we obtain globules upon the charcoal. In order to this, it is necessary, however, that the charcoal be solid, and be not cracked, and that we should not have blowed too strongly; otherwise the globules would be absorbed, and would disappear. The sulphate of lead requires a longer time to be reduced than the oxalate of the same metal, and there is a greater hazard of losing the metallic particles, which, beside, are in small quantity.

"To these two first processes, already sufficiently certain of themselves, I wished to be able to add one which might be capable of pointing out instantly the presence of lead, by an appearance belonging exclusively to this metal, and which might unite to this advantage that of manifesting very small quantities of it. Distilled water impregnated with sulphurated hydrogenous gas, or hepatic gas, extricated from solid alkaline sulphurets (*livers of sulphur*) by acids, presented me with these properties. This solution blackens very deeply that of the aceto-tartrite of lead, and renders $\frac{1}{1000}$ of this salt in water or in wine very sensible. The sensibility of this reactive is such, that we may dilute litharged wine with a sufficient quantity of water to take away almost entirely the colour of the wine, and this reactive will still produce a very manifest alteration. The sulphurated water has, besides, the advantage not to occasion any change in the wines which do not contain a metallic substance, and it is not precipitated by the acids of wine, like the solutions of alkaline sulphurets. In order to procure this reactive pure, it is necessary to prepare it at the instant of the experiment, by receiving in a vial full of distilled water, and inverted upon a shelf of a small hydro-pneumatic apparatus, filled with distilled water, the sulphurated hydrogenous gas, separated from the solid sulphuret of potash by the sulphuric or muriatic acid, and first filtrated through water in another vial; when the second vial contains the third of its volume of the sulphurated hydrogenous gas, the gas is shaken strongly with the water, which fills the two-thirds of the

the vial; and when the absorption is over, the test liquor is prepared. This re-active changes very quickly in the air: it is necessary to make it the moment it is to be employed, and to keep it in a vessel quite full and well corked. If there were any fear that the black colour and the precipitation by the gaseous sulphurated water should not be sufficient to prove the presence of lead in spirituous liquors, I would observe, that this fear would be diminished by employing the three re-actives mentioned in this memoir, and by depending only on the correspondent effects of these three re-actives: but all suspicion would be removed, by reducing the three precipitates by the blow-pipe, and obtaining globules of lead from each of them."

12 Method of detecting alum dissolved in wine.

Some years ago, the Academy of Lyons proposed the following prize-question: What is the best method of ascertaining the presence and the quantity of *alum* dissolved in wine, especially in very deep coloured red wine? The prize was gained by M. J. S. Beraud. From his experiments, it appears that a mixture of lime-water and wine in any proportion whatever, will at the end of 12 or 15 hours furnish a quantity of crystals, which may be separated by filtration, and that these crystals will be easiest discovered when the quantities of wine and lime-water are equal; but that wine containing alum dissolved in it, will not form crystals, when mixed with lime-water, but merely deposits a muddy sediment. To know therefore whether any wine contains alum or not, we have only to mix a small quantity of it with lime-water: if crystals are formed, it contains no alum; if not, it does. Again, if wine contains alum, the residuum that remains after filtration will, as it dries, split into quadrilateral segments, which will detach themselves from the paper which contains them; but if the wine contains no alum, the residuum, after it is dry, will remain united and attached to the paper. If one measure of wine and two-thirds of a measure of lime-water deposit crystals, we are certain that if the wine contains alum, the proportion of that alum to the wine will be less than 1 to 1152; if, when equal parts of wine and lime-water are mixed, no crystals be deposited, we may be sure that more than $\frac{1}{400}$th part of the mass of wine consists of alum.

A great proportion of the wine consumed in this country is brought from Spain and Portugal; government has always discouraged the importation of French wines by heavy taxes. We are not sure how far such conduct is founded on good policy, as the French wines are confessedly the best, and might be the cheapest; but such is the jealousy and enmity that has always subsisted between Britain and France, that both nations have been contented to injure themselves, provided they could do a greater injury to their neighbours. Besides, the advantages which Britain derives from the Portugal trade are very great, and it would not be easy perhaps to secure them on any other terms.

13 Directions for the treatment of imported wines.

It may be worth while to insert here a few directions about the treatment of wines after they have been imported into this country.—On landing, the less they are exposed the better; for they are affected by the seasons, and more or less by climate. March and April are the proper times for shipping wines from France, and they will be landed in England and Ireland in the same degree of temperature. The great art in keeping wines is to prevent their fretting, which is done by keeping them in the same degree of heat. In spring and fall, the wines in Bourdeaux are subject to changes that may be dangerous, if not prevented by necessary rackings: these changes are solely the effects of the seasons. If wines are chilled, and of course turn foul, from being shipped and landed in cold weather, they will soon recover by putting them in a warm vault, well covered with saw-dust. As soon as they are in the vault, they ought to be covered up. But if shipped and landed in summer, if the smallest degree of fermentation be found on them, it will be requisite to dip the bung cloths in brandy, and leave the bungs loose for some days, to give it time to cool; and if in a fortnight or three weeks the fermentation do not cease, and the wine become bright, it will be proper to rack it (matching the hogsheads well with brimstone), and force it with the white of eight eggs. If it then becomes fine, bung it tight, and let it remain so until it is bottled. If wines new landed are wanted soon for the bottle, it will be necessary to force them immediately, and let them remain bunged close for at least a month, to recover from the forcing, or if two months the better; for wines bottled in high order come much sooner into drinking than if bottled when flat, which all wines are after forcing. Wine must never be bottled the least foul, which produces a tendency to fret; and if bottled in this state, will never come in order, but may possibly be lost; for this there is no remedy but repeated rackings; and care must be taken (after rinsing the hogsheads well and drawing them) to burn a good piece of match in them. This cools the wine, and there is no danger of hurting the colour, for it recovers it in a little time: but if it did, it is absolutely necessary; for if wine is suffered to continue on the fret, it will wear itself to nothing. Wines bottled in good order may be fit to drink in six months; but they are not in perfection before twelve: from that to two years they may continue so; but it would be improper to keep them longer, for wines in general have not the body they had formerly, from the vines being too much forced.

It sometimes happens that wines scuddy and stubborn will not fall with one or even two forcings. It will then be proper to give them five or six gallons of good strong wine, and force them with the whites of a dozen eggs, with a tea-spoonful of sand produced from sawing-marble, or a small spoonful of fine salt. Bottled wine in winter should be well covered with saw-dust, and if the vaults are cold and damp, strew it deep on the floor; if saw-dust is thrown upon the hogsheads, and their sides are bedded some inches thick, it will keep them from the fret.

The same treatment is to be regarded with white wines, except that they require to be higher matched, particularly Muscat wines; such as Frontignac, Beziers, &c. which being often sweetened with honey, are very subject to fret; and these only frequent rackings, with a great deal of brimstone, can cool. Hermitage, from not being sufficiently dried, and possessing more richness than claret, is also very liable to come on the fret, and will require much the same treatment as the Muscat wines. Attention should be had to bottle in fine weather, when the wind is north; but to avoid cold or frosty weather. The months of April and October are favourable. The best time to bottle port wine is four years

Wine.

years after the vintage, and to keep them two years in bottle when you begin to use them. When wines are racked, and the lees immediately passed through flannel bags into close-necked jars, and directly bottled, there will be very little loss by rackings, as the wine when fine may serve for filling up.

When wines are destined for warm climates, it may be proper to rinse the hogsheads with brandy; and in bottling many rinse the bottles and corks with it. Wines that have remained a certain time (three or four months) in a vault, and made fine by their lees, ought never to be sent into the country without first racking them, otherwise they may be liable to fret; and if bottled in that state, may not bring well.

When wines may be ordered for immediate drinking will be forced in the ordinary way, and in a few weeks after they are forced will be fit for the bottle. The forcings proper for claret are the whites of a dozen eggs, beat up with a tea-spoonful of fine salt, and well worked with a forcing rod. Take care to use no bad egg. This is for one hogshead.

The forcing for white wine is isinglass dissolved in wine. One ounce is sufficient for two hogsheads. No salt is to be used in forcing the white wines. See *Croft on Wines*, 8vo, 1788.

14 Receipt for making raisin wine.

We shall insert here the following receipt for making *raisin wine.*—To a 20 gallon vessel take 100 pounds of raisins; pick off the stalks, chop them grossly, and put them into an open tub more wide than deep. Add two parts in three of the water of them, and let them stand 15 days, stirring them well every day. Then strain and press them, putting aside the liquor that runs from them. Add the remainder of the water to the raisins that have thus been pressed, and let it stand upon them one week, frequently stirring them as before. Then press off the liquor, and add it to what you first collected; putting both runnings together into your vessel, together with one quart of brandy. To colour it, burn three-fourths of a pound of sugar into a small quantity of the liquor, and add this to the wine. When the liquor in the barrel has done singing, stop the vessel close, and let it stand till fit to be bottled. The greater the quantity which the vessel holds, and the longer it is kept in the wood, the better will it be.

As some of the hints for making wines in Champagne may be useful in the manufacture of the wines of this country, we insert the following abridged account of the different processes that are followed in making white and red champagne.

Great care is necessary for making white wine. The ripest bunches must be carefully gathered, freed from rotten, dry, and bruised grapes, put into large baskets covered with a cloth to keep them from the sun, carried to the shade, and kept there till the evening, when they are to be speedily pressed. The grapes being laid on the bed of the press, they are covered with three or four layers of flat stones, and the press turned. The juice having run for four or five minutes, the press is turned backward, the stones removed, the grapes which have protruded thrust into the heap, the stones replaced, and the press turned again. The juice from three of such pressures, which will not require an hour, is put by itself for the best wine into a vat, where it is left all night to settle.

The next morning the juice is poured off from the sediment, and put into new well rinsed casks. In these it ferments violently at first, but afterwards imperceptibly, till about the end of December it becomes fine, having gone through all the stages of fermentation. It is then racked off in dry weather, on a clear frosty day, and fined with isinglass. About a pound is sufficient for [illegible] puncheons. The isinglass being dissolved is well mixed, diluted with wine taken from the cask, then poured into it, and the whole well stirred by an instrument introduced at the bung-hole. The wine then enters into fermentation slightly again, till it be stopped by the cold weather, or by time. In a month or six weeks it is racked off again, and has another fining with half the quantity of isinglass.

For making red wine, the grapes are gathered with the same precautions as for making white, taking only the black grapes. These are bruised in particular vessels, by men treading on them with strong wooden shoes; part of the stalks are thrown away, and the must is left in covered vessels to ferment sufficiently to extract the colouring matter from the pellicles. In some years, three or four days are sufficient; in others it requires 10, 15, or even 20. When the fermentation begins, the husks and stalks are forced down so as to be covered with the must, either by means of strong poles furnished with cross pieces, or, which is better, by a couple of strong men going into the vat, and well treading and mixing its contents. When the air above the vat extinguishes a candle, the stalks and husks rise forcibly, whatever pains be taken frequently to sink them, that the must may not acquire a disagreeable taste; the contents of the vat experience a degree of ebullition, and the colouring matter is decomposed. The fermentation must be made to stop here, that the wine may not acquire a hard taste, which even time cannot destroy.

About the end of December, when the fermentation has ceased, the wine is racked off from the lees; about the middle of May it is racked off again; the barrels are fresh hooped, and the wine is put into the cellar. When it is to be sent to the consumer, it is racked a third time; the whites of five or six fresh eggs are well beaten up in a pint of water, for every puncheon holding 240 bottles. Good red champagne will keep in bottles from six to twelve years.

Wine-Press, a machine contrived to squeeze the juice out of grapes, and consisting of several pieces of timber, variously disposed, which compose three bodies of timber-work, closely united to the axis, which serves as a swing whereby it may be moved by the vice. Of these there are different sizes as well as different constructions; for an account of which, illustrated by figures, see Miller's Gardener's Dictionary, article *Wine-Press*.

Spirit of Wine, or *Alcohol*, a name given by chemists to every ardent spirit produced by distillation. See Chemistry *Index*.

WING, that part of a bird, insect, &c. whereby it is enabled to fly. See Bird and Ornithology.

Wings, in military affairs, are the two flanks or extremes of an army, ranged in form of a battle; being the right and left sides thereof.

WINTER, one of the four seasons or quarters of the year. See Season, &c.

Winter commences on the day when the sun's distance from the zenith of the place is greatest, and ends on the day

day when its distance is at a mean between the greatest and least.

Under the equator, the winter as well as other seasons returns twice every year; but all other places have only one winter in the year: which in the northern hemisphere begins when the sun is in the tropic of Capricorn, and in the southern hemisphere when in the tropic of Cancer; so that all places in the same hemisphere have their winter at the same time.

Winter-Berry. See Physalis, Botany *Index*.

WINTERA, a genus of plants of the class of polyandria, and in the natural system arranged under the 12th order, *Holoraceæ*. See Botany and Materia Medica *Index*.

WINTON, Andrew, a Scottish poet and historian of the 14th century; but very little is known of his life. He was a canon regular of St Andrews, and was prior of the monastery of St Serf in the island of Loch Leven in Kinross-shire; for in the chartulary of the priory of St Andrews there are several public instruments of Andrew Winton, as prior of Loch Leven. They are dated between the years 1395 and 1413, so that Winton must have been cotemporary with Barbour, whose merits are on several occasions celebrated by him. Winton is best known as the author of the *Orygynale Cronykill of Scotland.* This work was undertaken at the request of Sir John Wemyss, the ancestor of the noble family of that name. It remained neglected for several centuries, but in 1795 a splendid edition of that part of it relative to Scottish affairs, was published by Mr Macpherson. The time of Winton's death is unknown; but, as he mentions the death of Robert duke of Albany, which happened in 1420, the historian must have been alive at that time.

WIRE, a piece of metal drawn through the hole of an iron into a thread of a fineness answerable to the hole it passed through.

Wires are frequently drawn so fine as to be wrought along with other threads of silk, wool, flax, &c.

The metals most commonly drawn into wire are gold, silver, copper, and iron. Gold-wire is made of cylindrical ingots of silver, covered over with a skin of gold, and thus drawn successively through a vast number of holes, each smaller and smaller, till at last it is brought to a fineness exceeding that of a hair. That admirable ductility which makes one of the distinguishing characters of gold, is nowhere more conspicuous than in this gilt wire. A cylinder of 48 ounces of silver, covered with a coat of gold, only weighing one ounce, as Dr Halley informs us, is usually drawn into a wire, two yards of which weigh no more than one grain; whence 98 yards of the wire weigh no more than 49 grains, and one single grain of gold covers the 98 yards; so that the ten-thousandth part of a grain is above one-eighth of an inch long.

In 1784, Mr Roswag of Strasbourg presented to the board of trade some gauze made of iron wire, for which he received a reward; and the loom he invented for making it was lodged in the collection of machines at Vaucanson. In 1799 Mr Rochon made others, and coated them with a transparent glue, to be substituted instead of horn for ship lanterns, to be used between decks, and in engagements by night. He has since conceived, that with a thin coating of plaster they might be employed to preserve ships from fire, and buildings on shore still more easily; or at least that they might render the ravages of fire less frequent, and less terrible. These gauzes might be very useful too for theatrical decorations, which would not be liable to take fire. Their only inconvenience is their being so little flexible; but Mr Rochon does not despair of means being found by chemistry to remedy this imperfection, and it was with a view of calling attention to this subject, that he read a paper on it to the class.

Wire of Lapland. The inhabitants of Lapland have a sort of shining slender substance in use among them on several occasions, which is much of the thickness and appearance of our silver wire, and is therefore called, by those who do not examine its structure or substance, *Lapland wire.* It is made of the sinews of the rein deer, which being carefully separated in the eating, are, by the women, after soaking in water and beating, spun into a sort of thread, of admirable fineness and strength, when wrought to the smallest filaments; but when larger, is very strong, and fit for the purposes of strength and force. Their wire, as it is called, is made of the finest of these threads covered with tin. The women do this business; and the way they take is to melt a piece of tin, and placing at the edge of it a horn, with a hole through it, they draw these sinewy threads, covered with the tin, through the hole, which prevents their coming out too thick covered. This drawing is performed with their teeth; and there is a small piece of bone placed at the top of the hole, where the wire is made flat; so that we always find it rounded on all sides but one, where it is flat.

This wire they use in embroidering their clothes, as we do gold and silver; they often sell it to strangers, under the notion of its having certain magical virtues.

WISDOM, usually denotes a higher and more refined notion of things immediately presented to the mind, as it were, by intuition, without the assistance of ratiocination.

Sometimes the word is more immediately used, in a moral sense, for what we call *prudence*, or *discretion*, which consists in the soundness of the judgment, and a conduct answerable thereto.

Wisdom of Solomon, one of the books of the Apocrypha. It abounds with Platonic language, and was probably written after the Cabalistic philosophy was introduced among the Jews.

WIT, is a quality of certain thoughts and expressions, much easier perceived than defined. According to Mr Locke, wit lies in the assemblage of ideas, and putting those together with quickness and variety, wherein can be found any resemblance or congruity, thereby to make up pleasant pictures and agreeable visions to the fancy. Mr Addison limited this definition considerably, by observing, that every resemblance of ideas does not constitute wit, but those only which produce delight and surprise. Mr Pope defined wit to be a quick conception and an easy delivery: while, according to a late writer, it consists in an assimilation of distant ideas.

The word *wit* originally signified *wisdom.* A *witte* was anciently a *wise man:* the *wittenagemot*, or Saxon parliament, an assemblage of wise men. So late as the reign of Elizabeth, a man of pregnant *wit*, of great *wit*,

Wit.

wit, was a man of vast *judgment*. We still say, *in his wits, out of his wits*, for in or out of sound mind. The word, however, is now applied in a more limited sense.

Without attempting to expose the inaccuracy of the definitions above mentioned, or hazarding a definition of our own where so many eminent men have failed, we shall endeavour to show in what true wit consists.

It is evident that wit excites in the mind an agreeable surprise, and that this is owing entirely to the strange assemblage of related ideas presented to the mind. This end is effected, 1. By debasing things pompous or *seemingly* grave; 2. By aggrandizing things little or frivolous; 3. By setting ordinary objects in a particular and uncommon point of view, by means not only remote but apparently contrary. Of so much consequence are surprise and novelty, that, nothing is more tasteless, and sometimes disgusting, than a joke that has become stale by frequent repetition. For the same reason, even a pun or happy allusion will appear excellent when thrown out extempore in conversation, which would be deemed execrable in print. In like manner, a witty repartee is infinitely more pleasing than a witty attack: for though, in both cases, the thing may be equally new to the reader or hearer, the effect on him is greatly injured, when there is access to suppose that it may be the slow production of study and premeditation. This, however, holds most with regard to the inferior tribes of witticism, of which their readiness is the best recommendation.

Campbell's Philosophy of Rhetoric, vol. i.

We shall illustrate these observations by subjoining a specimen or two of each of these sorts of wit:

Of the first sort, which consists in the debasement of things great and eminent, Butler, amongst a thousand other instances, hath given us those which follow:

And now had Phœbus in the lap
Of Thetis taken out his nap:
And, like a lobster boil'd, the morn
From black to red began to turn.
Hudibras, part ii. canto 2.

Here the low allegorical style of the first couplet, and the simile used in the second, afford us a just notion of this lowest species, which is distinguished by the name of the *ludicrous*. Another specimen from the same author you have in these lines:

Great on the bench, great in the saddle,
That could as well bind o'er as swaddle,
Mighty he was at both of these,
And styl'd of *war*, as well as *peace*:
So some rats of amphibious nature,
Are either for the *land* or *water*.
Ibid. part i. canto 1.

In this coarse kind of drollery, those laughable translations or paraphrases of heroic and other serious poems, wherein the authors are said to be travestied, chiefly abound.

The second kind, consisting in the aggrandisement of little things, which is by far the most splendid, and displays a soaring imagination, these lines of Pope will serve to illustrate:

As Berecynthia, while her offspring vie
In homage to the mother of the sky,
Surveys around her in the blest abode,
An hundred sons, and every son a god:
Not with less glory mighty Dulness crown'd,
Shall take thro' Grubstreet her triumphant round;
And her Parnassus glancing o'er at once,
Behold a hundred sons, and each a dunce.

This whole similitude is spirited. The parent of the celestials is contrasted by the daughter of night and chaos; heaven by Grubstreet; gods by dunces. Besides, the parody it contains on a beautiful passage in Virgil adds a particular lustre to it. This species we may term *thrasonical*, or *the mock-majestic*. It affects the most pompous language, and sonorous phraseology, as much as the other affects the reverse, the vilest and most grovelling dialect.

To this class also we must refer the application of grave reflections to mere trifles. For that *great* and *serious* are naturally associated by the mind, and likewise little and trifling, is sufficiently evinced by the common modes of expression on these subjects used in every tongue. An apposite instance of such an application we have from Philips:

My galligaskins, that have long withstood
The winter's fury and encroaching frosts,
By time subdu'd, (*What will not time subdue!*)
An horrid chasm disclose. *Splendid Shilling.*

Of the third species of wit, which is by far the most multifarious, and which results from what may be called the queerness or singularity of the imagery, we shall give a few specimens that will serve to mark some of its principal varieties. To illustrate all would be impossible. The first shall be where there is an apparent contrariety in the things she exhibits as connected. This kind of contrast we have in these lines of Garth:

Then Hydrops next appears amongst the throng;
Bloated and big she slowly sails along:
But like a miser in excess she's poor,
And pines for thirst amidst her wat'ry store.
Dispensary.

A second sort is, where the things compared are what with dialecticians would come under the denomination of *disparates*, being such as can be ranked under no common genus. Of this we shall subjoin an example from Young.

Health chiefly keeps an Atheist in the dark;
A fever argues better than a *Clarke*:
Let but the logic in his pulse decay,
The Grecian he'll renounce, and learn to pray.
Universal Passion.

A third variety in this species springs from confounding artfully the proper and the metaphorical sense of an expression. In this way, one will assign as a motive what is discovered to be perfectly absurd, when but ever so little attended to; and yet from the ordinary meaning of the words, hath a specious appearance on a single glance. Of this kind we have an instance in the subsequent lines:

While thus the lady talk'd, the knight
Turn'd th' outside of his eyes to white,

As

As men of inward light are wont
To turn their optics in upon't.
Hudibras, part iii. canto 1.

For whither can they turn their eyes more properly than to the light?

A fourth variety, much resembling the former, is when the argument or comparison (for all argument is a kind of comparison) is founded on the supposal of corporeal or personal attributes in what is strictly not susceptible of them; as in this,

But Hudibras gave him a twitch
As quick as lightning in the breech,
Just in the place where honour's lodg'd,
As wise philosophers have judg'd:
Because a kick in that place more
Hurts honour than deep wounds before.
Ibid. part ii. canto 3.

The fifth, and only other variety which we shall mention, is that which arises from a relation, not in the things signified, but in the signs of all relations, no doubt the slightest. Identity here gives rise to puns and clinches; resemblance to quibbles, cranks, and rhimes: Of these it is quite unnecessary to exhibit specimens.

Wit, *John de*, a celebrated pensionary of Holland, and one of the greatest politicians of his time, was the son of Jacob de Wit, burgomaster of Dort, and was born in 1625. He became well skilled in civil law, politics, mathematics, and other sciences; and wrote a treatise on the Elements of Curved lines, published by Francis Schooten. Having taken his degree of doctor of law, he travelled into foreign courts, where he became esteemed for his genius and prudence. At his return to his native country in 1650, he became pensionary of Dort, then counsellor-pensionary of Holland and West Friesland, intendant and register of the fiefs, and keeper of the great seal. He was thus at the head of affairs in Holland; but his opposition to the re-establishment of the office of stadtholder, which he thought a violation of the freedom and independence of the republic, cost him his life, when the prince of Orange's party prevailed. He and his brother Cornelius were assassinated by the populace at the Hague in 1674, aged 47.

WITCH a person guilty of witchcraft.

WITCHCRAFT, a supernatural power which persons were formerly supposed to obtain the possession of by entering into a compact with the devil. They gave themselves up to him body and soul; and he engaged, that they should want for nothing, and that he would avenge them upon all their enemies. As soon as the bargain was concluded, the devil delivered to the witch an imp, or familiar spirit, to be ready at a call, and do whatever it was directed. By the assistance of this imp and the devil together, the witch, who was almost always an old woman, was enabled to transport herself in the air on a broomstick or a spit to distant places to attend the meetings of the witches. At these meetings the devil always presided. They were enabled also to transform themselves into various shapes, particularly to assume the forms of cats and hares, in which they most delighted; to inflict diseases on whomsoever they thought proper; and to punish their enemies in a variety of ways. Witchcraft.

The belief that certain persons were endowed with supernatural power, and that they were assisted by invisible spirits, is very ancient. The *sagæ* of the Romans seem rather to have been sorcerers than witches; indeed the idea of a witch, as above described, could not have been prevalent till after the propagation of Christianity, as the heathens had no knowledge of the Christian *devil*.

Witchcraft was universally believed in Europe till the 16th century, and even maintained its ground with tolerable firmness till the middle of the 17th. Vast numbers of reputed witches were convicted and condemned to be burnt every year. The methods of discovering them were various. One was, to weigh the supposed criminal against the church bible, which, if she was guilty, would preponderate: another, by making her attempt to say the Lord's Prayer; this no witch was able to repeat entirely, but would omit some part or sentence thereof. It is remarkable, that all witches did not hesitate at the same place; some leaving out one part, and some another. Teats, through which the imps sucked, were indubitable marks of a witch: these were always raw, and also insensible; and if squeezed, sometimes yielded a drop of blood. A witch could not weep more than three tears, and that only out of the left eye. This want of tears was, by the witch-finders, and even by some judges, considered as a very substantial proof of guilt. Swimming a witch was another kind of popular ordeal generally practised; for this she was stripped naked, and cross-bound, the right thumb to the left toe, and the left thumb to the right toe. Thus prepared, she was thrown into a pond or river, in which, if guilty, she could not sink; for having, by her compact with the devil, renounced the benefit of the water of baptism, that element, in its turn, renounced her, and refused to receive her into its bosom. Sir Robert Filmer mentions two others by fire: the first, by burning the thatch of the house of the suspected witch; the other, burning any animal supposed to be bewitched by her, as a hog or ox. These, it was held, would force a witch to confess. *Provincial Glossary.*

The trial by the stool was another method used for the discovery of witches. It was thus managed: Having taken the suspected witch, she was placed in the middle of a room upon a stool or table, cross-legged, or in some other uneasy posture; to which if she submitted not, she was then bound with cords; there she was watched, and kept without meat or sleep for the space of 24 hours (for, they said, within that time they should see her imp come and suck). A little hole was likewise made in the door for imps to come in at; and lest it should come in some less discernible shape, they that watched were taught to be ever and anon sweeping the room, and if they saw any spiders or flies, to kill them: if they could not kill them, then they might be sure they were imps. If witches, under examination or torture, would not confess, all their apparel was changed, and every hair of their body shaven off with a sharp rasor, lest they should secrete magical charms to prevent their confessing. Witches were most apt to confess on Fridays.

By such trials as these, and by the accusation of children, Witchcraft.

dren, old women, and fools, were thousands of unhappy women condemned for witchcraft, and burnt at the stake. In the 18th volume of the Statistical Account of Scotland there is the trial of two witches, William Coke and Alison Dick, in Kirkaldy, in 1636. The evidence on which they were condemned is absolutely ridiculous: they were, however, burnt for witchcraft. The expences which the town and kirk-session were put to on this occasion were as follows:

	L.	s.
In primis.—To Mr James Miller, when he went to Prestowne for a man to try them, 47s. - -	L.2	7
Item.—To the man of Culross, (the executioner), when he went away the first time, 12s. - -	0	12
Item.—For coals for the witches, 24s.	1	4
Item.—In purchasing the commission,	9	3
Item.—For one to go to Finmouth for the laird to sit upon their assize as judge, - - -	0	6
Item.—For harden to be jumps to them,	3	10
Item.—For making of them, -	0	8
Summa for the kirk's part	L.17	10 Scots.

The town's part of expences debursed extraordinarily upon William Coke and Alison Dick.

	L.	s.	d.
In primis.—For 10 loads of coals to burn them, 5 merks, -	L.3	6	8
Item. For a tar barrel, 14s. -	0	14	0
Item.—For towes, - -	0	6	0
Item.—To him that brought the executioner, - -	2	18	0
Item.—To the executioner for his pains, - - -	8	14	0
Item.—For his expences here,	0	16	4
Item.—For one to go to Finmouth for the laird, - -	0	6	0
Summa town part,	L.17	1	0 Scots.
Both,	L.34	11	0
Or	L. 2	17	7 Ster.

Dr Ferriar, Manchester Trans. vol. iii.

For a considerable time after the inquisition was erected, the trials of witches (as heretics) were confined to that tribunal; but the goods of those who were condemned being confiscated to the holy office, its ministers were so active in discovering sorcerers, that the different governments found it necessary to deprive them of the cognisance of this crime. On the continent, commissioners were then appointed for the discovery and conviction of witches, who, though less active than the inquisitors, were but too zealous in prosecuting their function. In 1494, Sprenger and Institor, two persons employed in this commission, published a collection of trials, most of which had come before themselves, under the title of *Malleus Maleficarum:* this served as a kind of institute for their successors.

The first writers against witchcraft were stigmatized as Atheists, though they only endeavoured to prove the imbecility of the persons accused, and the infatuation or the knavery of their accusers. Such were the epithets bestowed by Dr Henry More, and even by Cudworth himself. Wierus, the disciple of the celebrated Agrippa, gave rise to the first great controversy on this subject. His master had taught him humanity; and he endeavoured, but with too feeble a hand, to stop the bloody proceedings of the judges. Wierus appears to have been a well-disposed, weak man, with extensive reading on his subject, but too narrow-minded to comprehend it thoroughly. He involved himself in unspeakable difficulties, by admitting the action of supernatural powers in certain diseases, and in possessions, while he denied that witches had any concurrence in them. These appearances (said he) are illusions of the devil, who persuades simple and melancholy persons that the mischief he himself performs, is done by them, and at their pleasure. He was weak enough to attempt the explanation of every story alleged by his antagonists, without questioning the truth of the facts.

Bodinus, a French lawyer of eminence, who had assisted at several trials of witches, wrote against Wierus, in his *Demonomania.* He urged the concurrent testimonies of sufficient witnesses, and the confessions of the witches themselves, to establish the existence of sorcery. Wierus owned that the unhappy persons believed themselves to be guilty of the crimes alleged against them, but that they were deceived by the devil. But what do you make of the witches meetings, cried Bodinus? The witches (replied his antagonist) are atrabilious. This explanation was so unsatisfactory that Wierus passed for a magician, whom the devil had furnished with specious arguments to save others from punishment. Lercheimer Godelmann, Ewichius, Ewaldus, and some others, followed him, notwithstanding this stigma; but they were opposed by men of more acuteness and consistency than themselves; by Remigius, who had condemned several hundreds of sorcerers to the flames; Delrio, whose book is a complete Corpus Magiæ; Cujas, Erastus, Scribonius, Camerarius, and a crowd of others.

In this country, while the belief in witchcraft was supported by royal authority (for James I. is universally known to have written on demonology) countenanced by Bacon, and generally adopted among the people, only one writer was hardy enough to oppose it. This was Reginald Scott, who published a collection of impostures detected, under the title of Discoveries of Witchcraft. James ordered the book to be burnt by the common executioner, and the judges continued to burn witches as usual. During the civil wars, upwards of eighty were hanged in Suffolk, on the accusations of Hopkins the witch-finder. Webster was the next writer against witchcraft; but he had a different fate from that of Scott, for most of his arguments were refuted by Glanville. This very acute writer was induced to publish his Philosophical Considerations about Witchcraft, by the apprehension, that the increasing disbelief of witches and apparitions tended to affect the evidences of religion, and even of a Deity. In respect of argument, he was certainly superior to his adversaries; his reasoning is perspicuous, though sometimes subtle, rested on the most specious foundations of evidence, and arranged with great skill.

On the continent, this controversy seemed almost forgotten, till Bekker published his *Monde Enchanté,* in which he denied the existence of witches, on the Cartesian principle, that the Deity is the source of all action, consequently actions so opposite to his nature and attributes cannot be supposed to exist. He was answered by Frederick

Frederick Hoffman, the father of the modern theory and practice of medicine, in his dissertation *De Diaboli Potentia in Corpora*.

The latest witchcraft frenzy was in New England, about 1692, when the execution of witches became a calamity more dreadful than the sword or the pestilence. The accusers became so daring, that neither civil nor religious authority would have proved a security against their attacks, if all the prosecutions had not been suddenly dropped, and the prisoners set at liberty. So far did those wretches proceed in absurdity, that a dog was accused of throwing persons into fits by looking at them. As soon as the prosecutions were stopped, all reports of witchcraft ceased.

It would be ridiculous to attempt a serious refutation of the existence of witches; and at present, luckily, the task is unnecessary. In this country, at least, the discouragement long given to all suspicion of witchcraft, and the repeal of the statutes against that crime, have very much weakened, though perhaps they have not entirely eradicated, the persuasion. On the continent, too, it is evidently on the decline; and notwithstanding the exertions of Dr De Haen, and of the celebrated Lavater, we have little doubt but that in a short time posterity will wonder at the credulity of their ancestors. That there ever were witches, is an opinion that cannot for a moment be believed by a thinking man. The actions imputed to them were either absurd or impossible; the witnesses by whose evidence they were condemned, either weak enthusiasts or downright villains: and the confessions ascribed to the witches themselves, effects of a disordered imagination produced by cruel treatment and excessive watchings. As to the nightly meetings, demonologists themselves have been obliged to confess, that they were nothing else but uneasy dreams, often produced by soporific compositions. The facts which have been brought forward by the advocates for witchcraft bear in their front the most evident marks of trick and imposture; and this has constantly been found out whenever these facts have been properly examined. See SORCERY.

WITENA MOT, or WITENA *Gemot*, among the Anglo-Saxons, was a term which literally signified the assembly of the wise men; and was applied to the great council of the nation, of latter days called the *parliament*.

WITHERS *of a* HORSE, the juncture of the shoulder-bones at the bottom of the neck and mane, towards the upper part of the shoulder.

WITNESS, in *Law*, a person who gives evidence in any cause, and is sworn to speak the truth, the whole truth, and nothing but the truth.

Trial by WITNESS, a species of trial without the intervention of a jury. This is the only method of trial known to the civil law, in which the judge is left to form in his own breast his sentence upon the credit of the witnesses examined: but it is very rarely used in the English law, which prefers the trial by jury before it in almost every instance. Save only that when a widow brings a writ of dower, and the tenant pleads that the husband is not dead; this being looked upon as a dilatory plea, is in favour of the widow, and for greater expedition allowed to be tried by witnesses examined before the judges: and so, saith Finch, shall no other case in our law. But Sir Edward Coke mentions some others; as, to try whether the tenant in a real action was duly summoned, or the validity of a challenge to a juror: so that Finch's observation must be confined to the trial of direct and not collateral issues. And in every case Sir Edward Coke lays it down, that the affirmative must be proved by two witnesses at the least.

WITTENBERG, a city of Germany, capital of the circle of Upper Saxony, 50 miles north of Dresden. The town is not large; but is well fortified, and contains a famous university, in which Melancthon was a professor. In this place Martin Luther first began to preach against the pope's indulgences; and in the cathedral of All Saints he is said to have been buried. In the old citadel of this town the ancient Saxon electors used to reside. Besides the university, there is a Latin school in the town, with six masters. The library belonging to the university is said to be very valuable. In 1756, the Prussians being masters of the town, destroyed a part of its fortifications. This town belonged to the elector, now king of Saxony, but was included in the country which he was compelled to cede to Prussia in 1814. E. Long. 12. 47. N. Lat. 51. 49.

WOAD. See ISATIS, BOTANY *Index*; see also DYEING.

The preparation of woad for dyeing, as practised in France, is minutely described by Astruc, in his Memoirs for a Natural History of Languedoc. The plant puts forth at first five or six upright leaves, about a foot long and six inches broad: when these hang downwards, and turn yellow, they are fit for gathering: five crops are gathered in one year. The leaves are carried directly to a mill, much resembling the oil or tan mills, and ground into a smooth paste. If this process was deferred for some time, they would putrefy, and send forth an insupportable stench. The paste is laid in heaps, pressed close and smooth, and the blackish crust, which forms on the outside, reunited if it happens to crack: if this was neglected, little worms would be produced in the cracks, and the woad would lose a part of its strength. After lying for fifteen days, the heaps are opened, the crust rubbed and mixed with the inside, and the matter formed into oval balls, which are pressed close and solid in wooden moulds. These are dried upon hurdles: in the sun, they turn black on the outside; in a close place, yellowish, especially if the weather be rainy. The dealers in this commodity prefer the first, though it is said the workmen find no considerable difference betwixt the two. The good balls are distinguished by their being weighty, of an agreeable smell, and when rubbed, of a violet colour within. For the use of the dyer, these balls require a farther preparation: they are beat with wooden mallets, on a brick or stone floor, into a gross powder; which is heaped up in the middle of the room to the height of four feet, a space being left for passing round the sides. The powder, moistened with water, ferments, grows hot, and throws out a thick fetid fume. It is shovelled backwards and forwards, and moistened every day for twelve days; after which it is stirred less frequently, without watering, and at length made into a heap for the dyer.

WOAHOO, one of the Sandwich islands, lying to the north-west of Morotoi, at the distance of seven leagues. From the appearance of the north-east and north-west parts, it is the finest island of the group. Nothing can exceed the verdure of the hills, the variety of of wood and lawn, and rich cultivated valleys, which the whole face of the country displays. A bay is formed by the north and west extremities, into which a fine river empties itself, through a deep valley; but as the water is brackish for 200 yards from the entrance, watering in it is not convenient. It contains about 60,000 inhabitants. Lieutenant Hergest, commander of the Dædalus store-ship, who had been sent from England, in 1791, to New South Wales, and thence to the Southern Pacific ocean, with a supply of provisions for the Discovery sloop, Captain Vancouver, then on a voyage of discovery, was here surprised and murdered by the natives, together with Mr Gooch, the astronomer. W. Long. 157. 51. N. Lat. 21. 43.

WODEN. See ODIN, and MYTHOLOGY, N° 40.

WODEVILLE, ANTHONY, earl of Rivers, brother to the queen of Edward IV. was born in the end of 1442, or in the beginning of 1443. Though one of the most accomplished men of his age, very little is known of his private history. He was early and constantly employed either in the tumults of those turbulent times, or in discharging the duties of some of the highest offices of the state, with which he was invested. Yet he found leisure to cultivate letters, and to be the author of works which, though of little value now, made some noise in that age, when learning was at a low ebb in England. These consisted chiefly of translations from the French; and his lordship and his printer Caxton, were the first English writers who had the pleasure to see their works published from the press. This accomplished, brave, and amiable nobleman was treacherously imprisoned by Richard III. in Pomfret castle, where, during his confinement, he composed a short poem, which has been preserved by John Rous of Warwick, and breathes, says Dr Henry, a noble spirit of pious resignation to his approaching fate. He was beheaded on the 23d of June 1483, in the 41st year of his age.

WODROW, ROBERT, a clergyman of the west of Scotland, who lived in the beginning of the 18th century, well known as the author of an Ecclesiastical History of that kingdom during the latter part of the preceding century. His father, Mr James Wodrow, was a man of learning and piety. He preached occasionally to the persecuted presbyterians, and taught a little academy of their students of philosophy and theology at Glasgow, before the Revolution. About that time he was ordained one of the ministers of that city, continuing his connexion with the academy till he was elected professor of theology by the university in the year 1692. He taught with reputation and success till his death in 1708.

His son Robert was born in the year 1679; his mother being then in the 51st year of her age. Her death (though it did not happen till several years after), was then fully expected; and his father, obnoxious to a tyrannical government, narrowly escaped imprisonment, or something worse, by attempting to obtain a last short interview with her. As he passed the town guard-house, he was marked, and soon followed by the soldiers into his own house, and even into his wife's bedchamber, where he was concealed. Their officer checked this violence; sent them out of the room, and left the house himself; placing, however, centinels both within and without, till the birth should be over. In half an hour after, Mr Wodrow at his wife's suggestion assumed the bonnet and great-coat of the servant of the physician then in attendance; and carrying the lantern before him, made an easy escape through the midst of the guards. They soon renewed their search with marks of irritation, thrusting their swords into the very bed where the lady lay; who pleasantly desired them to desist, "for the bird (said she) is now flown."

His son Robert went through the usual course of literary education at Glasgow, entered the university in 1691; and prosecuted the study of the languages and the different branches of philosophy, till he became a student of theology under the tuition of his father. He was chosen librarian to the university in the year 1698, and continued in that office four years. There he began his researches into every thing connected with the ecclesiastical history of his country, which he continued to pursue to the end of his life; and also imbibed his taste for medals, inscriptions, and whatever seemed curious or illustrative of Roman, Celtic, and British antiquities.

He was among the first in Scotland who attended to the study of natural history. From a great number of letters in his own hand-writing, begun about this time, it appears that he was in habits of the utmost intimacy with a select number of literary gentlemen, animated with the same ardour of research; that they corresponded regularly with one another, made collections of singular stones, of fossils, petrified plants, fishes, &c. and exchanged what they could spare from their respective stores. Among his correspondents were Mr William Nicolson, archdeacon, afterwards bishop of Carlisle, and at last of Derry, author of the Historical Libraries; Mr Edward Lhwyd keeper of the Ashmolean closet at Oxford; Sir Robert Sibbald, physician in Edinburgh, author of a natural history of Scotland, and another of Fife; Lord Pitmedan; Messrs James Sutherland, Laughlan Campbell minister of Campbelton, and others. In a letter to Mr Lhwyd, dated August 1709, Mr Wodrow tells him his manse was but at a little distance from a place where they had been lithoscoping together, during a visit of Mr Lhwyd to Scotland. "My parochial charge (he continues) does not allow me the same time I had then for those subterranean studies; but my inclination is equally strong, perhaps stronger. I take it to be one of the best diversions from serious study, and in itself a great duty, to admire my Maker's works. I have gotten some store of fossils here from our marle, limestone, &c. and heartily wish I had the knowing Mr Lhwyd here to pick out what he wants, and help me to class a great many species which I know not what to make of." He informs him, in the end of the letter, that he had 500 or 600 species of one thing or another relative to natural history.

Mr Wodrow, when he left Glasgow, resided a short time in the neighbourhood, in the house of a very distant relation, Sir ——— Maxwell of Nether Pollock, then one of the Scots judges. It being within the bounds of the presbytery of Paisley, he offered himself to them for probationary trials, and obtained their licence to preach the gospel in March 1703. In the summer following, the parish of Eastwood, where Lord Pollock lived, becoming vacant, by the death of Mr Matthew Crawford (another Scots historian), a petition, with an unanimous *call* or invitation from the parish to Mr Wodrow to be their minister, was presented to the presbytery;

Wodrow. presbytery; and they, waving part of the usual second trials, in order to expedite the business, ordained Mr Wodrow to be minister of Eastwood on the 28th of October 1703. In this charge he continued to the end of his life. Notwithstanding his ministerial duty, he still found some time to gratify the early bent of his mind towards natural history, and his curiosity to learn every thing in his power, not only at home, but concerning the natural productions of other countries, and the opinions, customs, manners, and way of living of their inhabitants. In his farewell letters to his friends, about to sail to the Scottish settlement of Darien or to the coast of Africa, &c. he directed their attention and enquiries to these subjects; and something similar he suggested to other friends going to reside in remote places of the Highlands, or even on the continent of Europe. The collection of his MS. letters bound up in five or six thick 8vo volumes, though reaching nearly to the end of his life, seems to consist only of the first draught of his own letters to his friends, not a single scrap is now to be found of their answers to him.

After his ordination, however, this worthy man, considering the duties of his office as his principal and only proper business, rose into distinguished reputation and usefulness as a preacher, and was looked upon as one of the first clergymen in the west of Scotland. Humble and unambitious of public notice, he was well entitled to it, by his conscientious and exemplary piety, his learning, not only in professional, but in other branches of knowledge, his natural good sense and solid judgment, his benevolent obliging spirit to all, his warm attachment to his friends, who formed a wide circle around him, and especially his deep concern for the best interests of his people, and active exertions for their instruction and improvement. His weekly sermons were all distinctly written out in long hand, and even his lectures in short-hand. Accustomed to regular composition, he had acquired an uncommon facility in it. His countenance and appearance in the pulpit was manly and dignified; his voice clear and commanding, his manner serious and animated: these things, joined with the general prejudice in his favour, added to the impression of the plain edifying discourses he delivered, without papers, to his hearers; and living in the near neighbourhood of Glasgow, his little church was often crowded, especially when he dispensed the Lord's Supper, considered in Scotland as the principal religious solemnity.

Yet these talents, and this merited popularity which followed them, made little impression on his own modest conscientious mind; for he chose to continue in the obscure country parish with which he was first connected, resisting all the attempts made by his friends or by strangers to get him translated into several other more honourable and opulent parishes, who were desirous of the benefit of his ministry, however convenient the change might have proved for the education of his family. In the year 1712, the magistrates of Glasgow invited him to be one of the ministers of that city; and in January 1717, a deputation from the town of Stirling did the same. On the other hand, the patron, heritors, and elders of his own parish, strenuously opposed the translation. The presbytery, who had it in their power to have appointed it, found great difficulties in both cases on the plea of the *majus bonum ecclesiæ*; referred the decision in the first case to the synod, and in the last to the commission of the General Assembly, and these courts thought proper to put no restraint on the minister's judgment or inclination, as he himself was certainly the best judge of his comparative usefulness in two different situations.

Mr Wodrow was equally conscientious and assiduous in the business of the ecclesiastical courts, as in his parochial duty. Notwithstanding his studious turn, he punctually attended the meetings of Presbytery, Synod, and General Assembly, when elected, as he often was, a member of that court; and also the commissions in November and March, which regularly met during that period of the church. His connexion with Lord Pollock made his journeys to Edinburgh easy: and after he began to collect materials for his voluminous history, his personal inspection of the public records and of the various MSS. accumulated in the Edinburgh libraries, made his visits to that capital frequent and necessary.

In common with the great body of the Presbyterians, he had strongly imbibed what are called Whig principles; in other words, he was warmly attached to the constitutional liberties of the people, as established by the revolution settlement. No wonder! The dreadful persecution and oppression they had suffered during the two preceding reigns were still fresh and galling to their minds: they considered the elevation of King William to the throne, and the Hanover succession, as the two chief bulwarks raised up by Providence, for the security both of their religion and liberty. They trembled at every dark appearance threatening to this security, such as the death of King William. That cloud, however, was soon dissipated by the perseverance of the queen's ministers in his views and measures, and the splendid victories of Marlborough and his allies over the armies of Louis XIV. But the elevation of the Tory ministry in the latter part of the queen's reign was a severe trial to the Scottish Presbyterians, and involved the conscientious part of the clergy in very serious difficulties and dangers. The oath of abjuration required at that time from clergymen, and enforced by civil penalties, and even the royal proclamation for a national thanksgiving, after the peace of Utrecht, pressed hard upon the scrupulous consciences of many of the clergy. The very language of the *oath* seemed to them dubious and jesuitical, hostile to the elector of Hanover's newly acquired right to the crown, conferred on him by the parliament and the people; and, as to the other point, they had not freedom to lead their people, in a solemn thanksgiving to Heaven for a peace, termed safe and honourable, which they and the generality of their hearers considered as dangerous and disgraceful. Mr Wodrow, as might be expected, was one of the recusants of the oath: for nothing could move him to shuffle with his conscience. At the same time the liberality and equity of his mind led him to judge candidly of the consciences of others. Accordingly, he made every effort in his power to reconcile his clerical brethren, and his own people, to such of the clergy as had the freedom to take it, and by so doing, had rendered themselves obnoxious to popular prejudice and odium. With such, this good man still continued to live, not only in Christian, but ministerial communion; endeavouring to soften and remove the prejudices against them, and, in as far as his influence reached, to revive and cherish a spirit of mutual forbearance. Many proposals be made, and private meetings

Wodrow. meetings and conferences he held with his brethren, to prevent their differences from rising, as they threatened to do, into a schism; to prevent them especially from entering at all into the church courts; justly afraid of the sparks of animosity too apt to be kindled there. His endeavours and those of his friends were seconded by the prudence of the superior courts, especially the commission of the General Assembly. Whatever passed there in the way of admonition to the rest of the church, breathed the spirit of mutual forbearance and love. How he managed the other difficult and delicate point, *the Thanksgiving*, in a consistency with his duty, does not appear in his letters; nor is it now worth while to investigate this as a trait of his character, which might be done, perhaps, from his MS. sermons preached at the time. Only it is pleasing to remark from the letters, that the same spirit of wisdom and mild forbearance which animated the majority of the clergy in the west, seems also to have pervaded the officers of the crown, justices of the peace, and other civil magistrates in Scotland at the time. The oath was not pressed on the recusants, and the execution of the legal penalties incurred by the neglect of it avoided; for their general loyalty was undoubted.

A more severe stroke was inflicted on their adversaries by the Tory ministry in the year 1710, by an act of the British parliament which restored patronage to its former full force. An act of the Scotch parliament passed after the Revolution had extracted the chief sting of that grievance, by placing the election of the minister of every parish in the hands of the landed proprietors, called heritors, in conjunction with the elders, or members of the kirk-session. A majority of that joint body, at a meeting appointed for the purpose, drew up a *call* or written invitation, which they subscribed, to a particular candidate to be their minister. This was presented to the presbytery of the bounds, the proper judges of his learning and moral character; and if these were found unexceptionable, he was ordained, or solemnly consecrated and installed into the office. This Scotch act having continued in force for twenty years, and being conceived to have become perpetual by the articles of the Union, was now repealed; and the choice of a minister to every parish was in effect placed in the power of a single person, a patron, because he had in fact the sole power of nominating the only candidate who could enjoy the benefice.

Mr Wodrow was exceedingly averse from the revival of the power of patronage; and in this he was influenced both by his political and religious principles. In his letters, he seems to have looked upon a patron of a parish, as a kind of hereditary despot; or at least like a prince, who had no restraints laid on his prerogative, to prevent or check the abuse of it. The paramount power or trust committed to a patron, this conscientious minister could not reconcile with the apostolical counsels, *to commit the keeping of religious truth to faithful men, able also to instruct others*. He thought it very improper to leave the choice of a religious instructor, in the first instance, to any single person whatever, especially to one generally a stranger to the circumstances of the parishioners; one who had little knowledge, and therefore little sympathy with them in their religious sentiments and feelings. He was persuaded that the purposes of edification, and the peace of the country, circumstanced as Scotland then was, were much better secured by the restraints laid on a patron in the act 1690, that is, by admitting the two principal bodies of the parish to a participation with him in his choice, than by trusting it wholly to himself; and he threw out many judicious hints in his letters, and even schemes or proposals to his brethren, on this difficult and important subject.

On the other hand, he wished nothing to be attempted but in a constitutional way, in harmony with the civil power. Few men were so sensible as he was of the abuses incident to popular government, either in church or state, and of the danger of resisting, even unjust and oppressive laws, in a tumultuous or disorderly manner. The Presbyterian church, in the outward order or form of it, he viewed as a well regulated republic. He did not consider the people in their individual capacity, as qualified to vote even on the choice of their own minister. The elders of the parish he looked upon as the representatives of the people in the ecclesiastical courts; and their number, in his own congregation, he restricted to a very few, four or five at most, fit to assist him in the exercise of church discipline within the parish. The rest of his session were deacons, whose jurisdiction was confined to the care of the poor, visiting the sick, and distributing the bread and wine at the communion, but could not, like the former, be chosen to represent the parish in the presbytery and superior courts. In this sense of the necessity of order and subordination, he persevered to the end of his life. When, contrary to *his* judgment or vote, an unpopular brother was to be ordained in a parish within twelve or fifteen miles distant from Eastwood, in consequence of a sentence of the General Assembly, to be executed, perhaps with military assistance; this aged minister thought it his duty, regardless of personal danger or odium, to countenance the young brother, by joining with the rest of the clergy in laying their hands on him, inviting him afterwards to his pulpit, and exerting any influence he had to conciliate the irritated minds of that parish.

The only publication for which the world is indebted to Mr Wodrow, is The History of the Singular Sufferings of the Church of Scotland during the twenty-eight years immediately preceding the Revolution. It was written at a proper distance of time from the events it records; and printed at Edinburgh in the year 1721, in two large folio volumes, with two appendixes consisting of copies of the public records, and of many private, family, and personal papers, letters, &c. inserted as vouchers of the historical facts. In collecting this great body of information, the author was assisted by his friends, who cheerfully seconded his own almost incredible industry and patience of research. In consequence of this, the book has more the appearance of a biographical, than of a historical work. It has, however, the form, and all the essentials of a regular history, divided into books, chapters, and sections, with proper margins and indexes; written in a plain, rather too familiar style, unavoidably interspersed with Scoticisms, yet these sufficiently intelligible to an English reader. It exhibits a distinct sketch of the characters both of the principal sufferers, and of their persecutors; of the springs of the persecution, in the unjustifiable plans and measures of an arbitrary government; with the motives of the advisers and executors of them. The unfortunate and innocent

Wodrow. innocent sufferers, our author viewed in the light, not of a set of wild fanatics, as they were called by their contemporaries, and frequently too by later historians; many of them were most respectable for their rank in their country, as well as for their talents and virtues; but even those in the lower ranks of society, our author thought worthy of some public notice, as confessors and martyrs in the noble cause which they had espoused, the support of the rights of conscience, and of national liberty.

The subject of the history is the most melancholy that could be chosen; a long and severe persecution of a people, who had been guilty of nothing undutiful to their civil or ecclesiastical rulers; a series of open acts of injustice and tyranny, perpetrated under the colour of law, and this with such an increasing and merciless violence, as to sink the usual spirit of a free people, and easily quash one or two feeble ill-timed attempts to resist their oppressors. No wonder that the continued view of such a wretched and melancholy scene, without any thing joyful to interrupt it, should give a melancholy tinge to the mind of the writer, easily communicated to his readers. On the other hand, some things have happily an opposite tendency. The mass of biographical intelligence, though it must be confessed it is much too voluminous, and too minute for the management of any historian whatsoever, yet furnishes a variety of anecdotes, which give some needful relaxation or relief to the sympathy of the reader. These indeed are in part the *simple annals of the poor*, without the varnish or easy elegance of polished life; but even in this shape they are not destitute, both of entertainment and instruction; and then the minuteness in the detail of names, of persons, places, and other particular circumstances, adds to the impression of the facts, by placing their certainty beyond all reasonable doubt.

If faithfully to record past facts, and transmit the knowledge of them to posterity, be the principal duty of a historian, this Wodrow has certainly aimed at; and also to repress any feelings hostile to his fidelity and impartiality; in short, to come as near as he was able to the motto prefixed to his volumes, *Nec studio, nec odio.* Doubtless, like all other men, he had some political, and many theological prejudices, the last chiefly imbibed from education, and confirmed by too high a veneration for the characters of our first reformers;—prejudices which warped his personal opinions and feelings on both subjects. But he seems to have made a considerable effort to prevent his party prejudices from warping or perverting his judgment of the truth or falsehood of stubborn historical facts. Nothing almost oratorial enters into his narratives, though there is room for admiration, and much scope for just indignation; no exaggerated encomiums on his friends, or strong opprobrious language in speaking of his and their enemies, the unprovoked persecutors of his church. He allows the facts which he has recorded to speak for both, and transmit to posterity a memorial to their honour or their infamy.

The chief fault of this historical collection already hinted at, is its minuteness, and excessive copiousness. The prodigious multitude of facts it embraces, though different from one another in their circumstances, are in other respects somewhat similar. This must necessarily occasion some repetition and satiety, especially to a fastidious reader, who has it, however, in his power to gratify his taste by selecting what is most agreeable to it. Nevertheless a candid and patient reader can be at no loss to form a proper judgment of the principal transactions of the period, from the authentic accounts of them before him, to appreciate the true characters of the actors, or of the motives and views from which they acted. And an inquisitive and penetrating reader will be gratified by seeing not a little of the peculiar principles, opinions, sentiments, habits, and manners of that age, as distinguished from the present; and may thus estimate the gradual progress towards much noble and useful improvement; and on the other hand, the progress towards a very hurtful corruption and degeneracy of manners, which have both taken place during the last hundred and twenty years.

Wodrow. At the time of its first publication, the book met with less general attention than might have been expected in Scotland, and scarcely any attention in England, except from professed readers. As it came to be more studied, it was the more valued, except where there was an evident bias on the opposite side. Few can be at a loss to see why such historians as Hume, Macpherson, and Dalrymple should neglect or undervalue such a book. Our later Scotch historians, Somerville and Laing, have done it more justice. In truth, there is a very near coincidence in their estimates of the characters they draw, and their accounts of the facts they relate, in common with Wodrow. But especially our late illustrious patriot Charles Fox, whose high abilities, uncommon candour, and sweetness of disposition, almost remove the suspected bias of his party spirit—Mr Fox has, in the historical fragment published since his death, given a very honourable testimony to the fidelity and accuracy of our historian. After mentioning the execution of three females, he adds, page 131. "To relate all the instances of cruelty which occurred would be endless. But it may be necessary to remark, that no historical facts are better ascertained, than the accounts of them which are to be found in Wodrow. In every instance, where there has been an opportunity of comparing these accounts with the records, and other authentic monuments, they appear to be quite correct."

The collection of the materials for writing the church history from the public records, and many other authentic sources, must have cost the author a prodigious labour and time. The pecuniary expence incurred was considerable, and scarcely refunded from the sale of the book. The only neat profit, he has been heard to say, which accrued from it, was one or two hundred pounds that he received from the king, to whom it was dedicated.

The last twelve years of Mr Wodrow's life were chiefly occupied in drawing up a biography of the principal persons concerned in introducing the reformation of religion into Scotland, and settling the different forms or modes of ecclesiastical government attempted to be established there from the beginning to the end of that period, namely from about the year 1560 to 1660, when the printed history of the sufferings commences. Had it pleased God to continue his useful life till this larger work was finished, public curiosity would have been much gratified; for it contains the lives, not only of John Knox, George Buchanan, and others already well known, but the lives of a great number more, very learned, ingenious, respectable, and worthy men, scarce-

Wodrow. ly at all known to the literary world; besides a variety of anecdotes naturally entering into such a work, illustrative of the history and the living manners of that age. Happily these manuscript lives are still preserved, all written with his own pen, and some of the longest of them copied, probably during his last long illness, in a more legible hand. Whatever important or curious information they may contain, they are not fit for the press in their present state. They are now deposited in the library of the university of Glasgow.

Besides writing the history and the biography, both extended by himself for publication, and two days every week regularly appropriated to his preparation for the pulpit, much of his time must have been occasionally spent in writing letters, some of them like dissertations, on theological and other literary subjects; for he corresponded with a very wide circle of acquaintances and friends in Scotland, England, and Ireland, and with a few on the continent and in North America.

His constitution in the first part of life was robust and strong, his health in general good; but his studious habits or constant reading, and especially incessant writing, it is supposed, may have brought on the bodily complaint which occasioned his death. In the latter end of the year 1731, a swelling about the size of a small chesnut appeared on his breast, near the collar bone. It was on the same place where a spark of fire had fallen when he was a child, and had then left a little lump and hardness like a large pea. About a month after the swelling began, it had increased to the size of a plumb, and in April 1732 was as large as a man's fist. It was attempted to be removed by caustic; the attempt failed. His body became greatly emaciated, and he gradually declined till his death, which happened on the 21st of March 1734. Supported by the testimony of a good conscience, joined with the strong consolation and well-founded hope of the gospel, he bore this long continued severe distress with admirable fortitude, unabated piety and resignation; never uttering a murmur, but behaving to his friends who came to see him, and to all about him, with much ease and affection; thus leaving, both in the active exertions of a useful life, and in his patient sufferings at the close of it, a very edifying example to his family and his flock. The day before his death, he gathered his children around his bed, gave each of them his dying blessing, with counsels suitable to their ages and circumstances; last of all two boys, neither of them four years old, too young to understand and feel these marks of his affection, yet, after the example of the venerable patriarch, Gen. xlviii. 15. even them he drew to him, laid his hands upon their heads, and devoutly prayed, *that the God of his fathers, the angel who had redeemed him from all evil, would bless the lads.*

Mr Wodrow was married in the end of 1708, to Margaret Warner, grand-daughter of the reverend Mr William Guthrie of Fenwick, well known in Scotland by his writings, and daughter of the reverend Patrick Warner, then living on his estate of Ardeer in Ayrshire. Mr Warner, in the early part of his life, had been chaplain to the East India Company at Madras. After his return home, he was driven from his ministry and from the kingdom, by the persecution of the privy council; but returned in consequence of King James's indulgence, and became minister of Irvine. He had a personal interview on his last return with the prince of Orange at the Hague, a short time before the Revolution, an account of which appears in the history, vol. ii. p. 604. Mr Wodrow had a family of 16 children, nine of whom, with his widow, survived him in decent circumstances, without any breach among them for above 25 years. Three of his sons were clergymen of the church of Scotland; one was minister of the parish of Cumbray, another of Tarbolton; and the third, the late Dr James Wodrow, author of the life of Dr Leechman of Glasgow, was minister of Stevenston in Ayrshire.

Besides his collection of fossils, and a few Roman and British medals, Mr Wodrow left a valuable library of books, many volumes of pamphlets and also of manuscripts written by others, sent to him in presents, or copied by his orders. The most valuable part of them is now in the advocates library, and in the repositories of the church at Edinburgh. His own manuscript biography, as has been already said, is in the library of the university of Glasgow.

WOLAW, a town in Germany, in Prussian Silesia, and capital of a duchy of the same name. It is surrounded with strong walls and a morass, and one part of the houses are built with stone. The castle is also encompassed with deep ditches, and the greatest part of the inhabitants are employed in a woollen manufactory. In 1709 a Protestant church was allowed to be built here. It is seated on the river Oder, 20 miles north-west of Breslau, and 32 south-east of Glogau. E. Long. 16. 54. N. Lat. 51. 18.

WOLD, WELD, *DYERS Weed*. See RESEDA, BOTANY *Index*, and DYEING.

WOLF. See CANIS, MAMMALIA *Index*.

WOLF-Fish, or *Sea-WOLF*. See ANARRHICAS, ICHTHYOLOGY *Index*.

WOLF or *Woolf Poison*. See POISON.

WOLFE, MAJOR-GENERAL JAMES, was born at Westerham in the county of Kent, about the beginning of the year 1726. His father was Lieutenant-general Edward Wolfe. He went into the army when very young; and applying himself with unwearied assiduity to the study of his profession, soon became remarkable for his knowledge and his genius. He distinguished himself at the battle of Lafelt when little more than 20, and received the highest encomiums from the commander in chief. After the peace he still continued to cultivate the art of war. He contrived to introduce the greatest regularity and the exactest discipline into his corps, and at the same time to preserve the affection of every soldier. In 1758 he was present as a brigadier-general at the siege of Louisbourg. He landed first on the island at the head of division; and in spite of the violence of the surf, and the force and well directed fire of the enemy, drove them from their post with great precipitation. The surrender of the town which happened soon after, was in a great measure owing to his activity, bravery, and skill. The fame which he acquired during this siege pointed him out to Mr Pitt, who was then minister, as the properest person to command the army destined to attack Quebec. This was the most difficult and the most arduous undertaking of the whole war. Quebec was the capital of the French dominions in North America; it was well fortified, situated in the midst of a hostile country, and defended by an army of 20,000 men, regulars and militia, besides a considerable number of Indian allies. The troops destined for this expedition consisted of ten battalions, making up altogether about 7000 men. Such was the army

Wolfe.

army destined to oppose three times their own number, defended by fortifications, in a country altogether unknown, and in a late season in that climate for military operations. But this little army, says an officer who was present at that expedition, and who has been so obliging as to communicate all the information we desired, was always sanguine of success; for they were commanded by General Wolfe, who, by a very uncommon magnanimity and nobleness of behaviour, had attached the troops so much to his person, and inspired them with such resolution and steadiness in the execution of their duty, that nothing seemed too difficult for them to accomplish. The admirable skill with which his measures were planned, and the prudence and vigour with which they were executed, are well known. He landed his army on the northern shore of the river St Lawrence in spite of the enemy, and forced them to a battle, in which they were completely defeated. The consequence of this battle was the reduction of Quebec, and the conquest of Canada. In the beginning of the battle General Wolfe was wounded in the wrist by a musket-ball: he wrapt his handkerchief round it, continued to give his orders with his usual calmness and perspicuity, and informed the soldiers that the advanced parties on the front had his orders to retire, and that they need not be surprised when it happened. Towards the end of the battle he received a new wound in the breast; he immediately retired behind the rear-rank supported by a grenadier, and laid himself down on the ground. Soon after a shout was heard; and one of the officers who stood by him exclaimed, "See how they run!" The dying hero asked with some emotion, "Who run?" "The enemy (replied the officer); they give way every where." The general then said, "Pray, do one of you run to Colonel Burton, and tell him to march Webb's regiment with all speed down to Charles river, to cut off the retreat of the fugitives from the bridge. Now, God be praised, I shall die happy!" He then turned on his side, closed his eyes, and expired.

The death of General Wolfe was a national loss universally lamented. He inherited from nature an animating fervour of sentiment, an intuitive perception, an extensive capacity, and a passion for glory, which stimulated him to acquire every species of military knowledge that study could comprehend, that actual service could illustrate and confirm. This noble warmth of disposition seldom fails to call forth and unfold all the liberal virtues of the soul. Brave above all estimation of danger; generous, gentle, complacent, and humane; the pattern of the officer, the darling of the soldier. There was a sublimity in his genius which soared above the pitch of ordinary minds; and had his faculties been exercised to their full extent by opportunity and action, had his judgment been fully matured by age and experience, he would, without doubt, have rivalled in reputation the most celebrated captains of antiquity. His body was brought to England, and buried with military honours in Westminster abbey, where a magnificent monument is erected to his memory.

Wolfe, *Christian*, a celebrated German philosopher, was born at Breslau in 1679. After having been well instructed in the rudiments of learning and science in his own country, Wolfe prosecuted his studies successively in the universities of Jena, Hamburgh, and Leipsic. At the age of 26 he had acquired so much distinction, that he was appointed professor of mathematics, and soon afterwards of philosophy in general, in the university of Hall. After Leibnitz had published his *Theodicea*, Wolfe, struck with the novelty of the edifice which that philosopher had raised, assiduously laboured in the investigation of new metaphysical truths. He also digested the Elements of Mathematics in a new method, and attempted an improvement of the art of reasoning, in a treatise On the Powers of the Human Understanding. Upon the foundation of Leibnitz's doctrine of Monads, he formed a new system of Cosmology and Pneumatology, digested and demonstrated in a mathematical method. His work, entitled Thoughts on God, the World, and the Human Soul, was published in the year 1719; to which were added, in a subsequent edition, Heads of Ethics and Policy.

Enfield's History of Philosophy, vol. ii.

Wolfe, Wolfenbuttle.

Wolfe was now rising towards the summit of philosophical reputation, when the opinion which he entertained on the doctrine of necessity being deemed by his colleagues inimical to religion, and an oration which he delivered in praise of the morality of the Chinese having given much offence, an accusation of heresy was publicly brought against him; and, though he attempted to justify himself in a treatise which he wrote on the subject of fatality, a royal mandate was issued in November 1723, requiring him to leave the Prussian dominions. Having been formerly invited by the landgrave of Hesse-Cassel to fill a professor's chair in the university of Cassel, Wolfe now put himself under the patronage of that prince, who had the liberality to afford him a secure asylum, and appointed him professor of mathematics and philosophy. The question concerning the grounds of the censure which had been passed upon Wolfe was now every where freely canvassed; almost every German university was inflamed with disputes on the subject of liberty and necessity; and the names of Wolfians and Anti-Wolfians were every where heard. After an interval of nine years, the king of Prussia reversed his sentence of exile, and appointed him vice-chancellor of the university of Hall; where his return was welcomed with every expression of triumph. From this time he was employed in completing his Institutes of Philosophy, which he lived to accomplish in every branch except policy. In 1745 he was created a baron by the elector of Bavaria, and succeeded Ludowig in the office of chancellor of the university. He continued to enjoy these honours till the year 1754, when he expired. He possessed a clear and methodical understanding; which, by long exercise in mathematical investigations, was particularly fitted for the employment of digesting the several branches of knowledge into regular systems; and his fertile powers of invention enabled him to enrich almost every field of science in which he laboured, with some valuable additions. The lucid order which appears in all his writings enables his reader to follow his conceptions with ease and certainty, through the longest trains of reasoning.

WOLFENBUTTLE, a considerable town of Germany, in the circle of Lower Saxony, and duchy of Brunswick, with a castle, where the duke of Brunswick Wolfenbuttle resides. It is one of the strongest places in Germany, though the fortifications want repairing in several places. There is an excellent library, kept in a building lately erected for that purpose, consisting of 116,000 printed books, and 2000 uncommon books, with

with a cabinet of curiosities, relating to natural history. It is seated on the river Ocker, five miles south of Brunswick, and 30 west of Halberstadt. E. Long. 10. 25. N. Lat. 52. 10.

WOLFRAM, or TUNGSTEN. See TUNGSTEN, CHEMISTRY and MINERALOGY *Index*.

WOLFSPERG, a town of Germany, in Lower Carinthia, with a castle, on which the district about it depends, which is 20 miles in length, and 10 in breadth. It is seated on the river Lavand, at the foot of a mountain covered with wood, and full of wolves, from whence the town took its name. It is 36 miles east of Clagenfurt. E. Long. 15. 0. N. Lat. 46. 56.

WOLGAST, a considerable town of Germany, in the circle of Upper Saxony, and in Pomerania, capital of a territory of the same name, with a castle, and one of the best and largest harbours on the Baltic sea. It is a well built place, subject to Prussia, and seated on the river Psin. E. Long. 13. 42. N. Lat. 54. 4.

WOLLASTON, WILLIAM, descended of an ancient family in Staffordshire, was born in 1659. He was in 1674 admitted a pensioner in Sidney college, Cambridge, where, notwithstanding several disadvantages, he acquired a great degree of reputation. In 1682, seeing no prospect of preferment, he became assistant to the head master of Birmingham school. Some time after, he got a small lecture about two miles distant, but did the duty the whole Sunday; which, together with the business of a great free-school for about four years, began to break his constitution. During this space he likewise underwent a great deal of trouble and uneasiness, in order to extricate two of his brothers from some inconveniences, to which their own imprudence had subjected them. In 1688 affairs took a new turn. He found himself by a cousin's will entitled to a very ample estate: and came to London that same year, where he settled; choosing a private, retired, and studious life. Not long before his death, he published his treatise, entitled The Religion of Nature Delineated; a work for which so great a demand was made, that more than 10,000 were sold in a very few years. He had scarcely completed the publication of it, when he unfortunately broke an arm; and this adding strength to distempers that had been growing upon him for some time, accelerated his death; which happened upon the 29th of October 1724. He was a tender, humane, and in all respects worthy man; but is represented to have had something of the irascible in his constitution and temperament. His Religion of Nature Delineated exposed him to some censure, as if he had put a slight upon Christianity, by laying so much stress, as he does in this work upon the obligations of truth, reason, and virtue; and by making no mention of revealed religion. But this censure must have been the offspring of ignorance or envy, since it appears from the introduction to his work, that he intended to treat of revealed religion in a second part, which he lived not to finish.

WOLSEY, THOMAS, a famous cardinal and archbishop of York, is said to have been the son of a butcher at Ipswich. He studied at Magdalen college, Oxford, where he became acquainted with the learned Erasmus; and in the year 1500 became rector of Lymington in Somersetshire: he was afterwards made chaplain to King Henry VIII. and obtained several preferments. Having gradually acquired an entire ascendency over the mind of Henry VIII. he successively obtained several bishoprics, and at length was made archbishop of York, lord high-chancellor of England, and prime minister; and was for several years the arbiter of Europe. Pope Leo X. created him cardinal in 1515, and made him *legate à latere;* and the emperor Charles V. and the French king Francis I. loaded him with favours, in order to gain him over to their interest; but after having first sided with the emperor, he deserted him to espouse the interest of France. As his revenues were immense, his pride and ostentation were carried to the greatest height. He had 500 servants; among whom were 9 or 10 lords, 15 knights, and 40 esquires. His ambition to be pope, his pride, his exactions, and his political delay of Henry's divorce, occasioned his disgrace. In the earlier part of his life he seems to have been licentious in his manners; it was reported, that soon after his preferment to the living of Lymington in Somersetshire, he was put into the stocks by Sir Amias Paulet, a neighbouring justice of the peace, for getting drunk and making a riot at a fair. This treatment Wolsey did not forget when he arrived at the high station of lord-chancellor of England; but summoned his corrector up to London, and, after a severe reprimand, enjoined him six years close confinement in the Temple. Whatever may have been his faults, there can be no doubt of their having been aggravated both by the zealous reformers and by the creatures of Henry VIII. who was himself neither Papist nor Protestant; for there is every reason to believe that the cardinal was sincere in his religion; and sincerity, or at least consistency, was then a crime. Wolsey was the patron of learned men; a judge and munificent encourager of the polite arts; and ought to be considered as the founder of Christchurch college, Oxford; where, as well as in other places, many remains of his magnificent ideas in architecture still exist. He died in 1530.

WOLVERENE. See URSUS, MAMMALIA *Index*.

WOLVES-TEETH, of a horse. See FARRIERY.

WOMAN, the female of the human species. See HOMO.

WOMB, or UTERUS. See ANATOMY, N° 108.

WOMBAT, an animal lately discovered in New South Wales. See DASYURUS, MAMMALIA *Index*.

WOOD, ANTHONY, an eminent biographer and antiquarian, was the son of Thomas Wood, bachelor of arts and of the civil law, and was born at Oxford in 1632. He studied at Merton college, and in 1655 took the degree of master of arts. He wrote, 1. The History and Antiquities of the University of Oxford; which was afterwards translated into Latin by Mr Wase and Mr Peers, under the title of *Historia et Antiquitates Universitatis Oxoniensis*, 2 vols folio. 2. *Athenæ Oxonienses;* or an exact Account of all the Writers and Bishops who have had their education in the University of Oxford, from the Year 1500 to 1600, 2 vols folio; which was greatly enlarged in a second edition published in 1721 by Bishop Tanner. Upon the first publication of this work the author was attacked by the university, in defence of Edward earl of Clarendon, lord high chancellor of England, and chancellor of the university, and was likewise animadverted upon by Bishop Burnet; upon which he published a Vindication of the Historiographer of the University of Oxford. He died at Oxford in 1695.

WOOD, a substance whereof the trunks and branches of trees consists. It is composed of a number of concentric circles or zones, one of which is formed every year; consequently their number corresponds to the age of the tree. These zones vary in thickness according to the degree of vegetation that took place the year of their formation. They are also of different degrees of thickness in different parts, that part of the tree which is most exposed to the sun and best sheltered growing fastest; hence in this country that part of the zone which looked towards the south while the tree was growing is generally thickest. The innermost circle or zone is the one which was first formed, the outermost was formed the year before the tree was cut down. These zones are at first very soft and tender, and harden by degrees as the tree becomes older: this is the reason that the middle of a tree is so often much better wood than the outside of it.

The proper ligneous part of the wood consists of longitudinal fibres, disposed in fasciculi, and possessed of considerable hardness. It is this longitudinal direction of the fibres that renders it so much easier to cleave wood lengthwise, than across the tree, or in any other direction. See PLANT and VEGETABLE PHYSIOLOGY.

For an account of the ingredients which enter into the composition of wood, see CHEMISTRY *Index*.

For the *Method of Staining or Dyeing Wood*, see TURNING.

For more complete information concerning wood, see also TREE, and *STRENGTH of Materials*.

Fossil WOOD. Fossil wood, or whole trees, or parts of them, are very frequently found buried in the earth, and that in different strata; sometimes in stone, but more usually in earth; and sometimes in small pieces loose among the gravel. These, according to the time they have lain in the earth, or the matter they have lain among, are found differently altered from their original state; some of them having suffered very little change; and others being so highly impregnated with crystalline, sparry, pyritical, or other extraneous matter, as to appear mere masses of stone, or lumps of the common matter of the pyrites, &c. of the dimensions, and, more or less, of the internal figure, of the vegetable bodies into the pores of which they have made their way.

The fossil woods have been arranged by Dr Hill into three kinds: 1. The less altered; 2. The pyritical; and, 3. The petrified.

Of the trees, or parts of them, less altered from their original state, the greatest store is found in digging to small depths in bogs, and among what is called *peat* or *turf earth*, a substance used in many parts of the kingdom for fuel. In digging among this, usually very near the surface, immense quantities of vegetable matter of various kinds are found buried; in some places there are whole trees scarce altered, except in colour; the oaks in particular being usually turned to a jetty black; the pines and firs, which are also very frequent, are less altered, and are as inflammable as ever, and often contain between the bark and wood a black resin. Large parts of trees have also been not unfrequently met with unaltered in beds of another kind, and at much greater depths, as in strata of clay and loam, among gravel, and sometimes even in solid stone.

Besides these harder parts of trees, there are frequently found also in the peat earth vast quantities of the leaves and fruit and catkins of the hazel and similar trees; these are usually mixed with sedge and roots of grass, and are scarce at all altered from their usual texture. The most common of these are hazel nuts; but there are frequently found also the twigs and leaves of the white poplar; and a little deeper usually there lies a cracked and shattered wood, the crevices of which are full of a bituminous black matter: and among this the stones of plums and other stone-fruits are sometimes found, but more rarely.

In this state the fruits and larger parts of trees are usually found: what we find of them more altered, are sometimes large and long, sometimes smaller and shorter branches of trees; sometimes small fragments of branches, and more frequently small shapeless pieces of wood. The larger and longer branches are usually found bedded in the strata of stone, and are more or less altered into the nature of the stratum they lie in. The shorter and smaller branches are found in vast variety in the strata of blue clay used for making tiles in the neighbourhood of London. These are prodigiously plentiful in all the clay-pits of this kind, and usually carry the whole external resemblance of what they once were, but nothing of the inner structure; their pores being wholly filled, and undistinguishably closed, by the matter of the common pyrites, so as to appear mere simple masses of that matter. These fall to pieces on being long exposed to moisture; and are so impregnated with vitriol that they are what is principally used for making the green vitriol or copperas at Deptford and other places.

The irregular masses or fragments of petrified wood are principally of oak, and are most usually found among gravel; though sometimes in other strata. These are variously altered by the insinuation of crystalline and stony particles; and make a very beautiful figure when cut and polished, as they usually keep the regular grain of the wood, and show exactly the several circles which mark the different years growth. These, according to the different matter which has filled their pores, assume various colours, and the appearance of the various fossils that have impregnated them; some are perfectly white, and but moderately hard; others of a brownish black, or perfectly black, and much harder; others of a reddish black, others yellowish, and others grayish, and some of a ferruginous colour. They are of different weights also and hardnesses, according to the nature and quantity of the stony particles they contain: of these some pieces have been found with every pore filled with pure pellucid crystal; and others in large masses, part of which is wholly petrified and seems mere stone, while the rest is crumbly and is unaltered wood. That this alteration is made in wood, even at this time, is also abundantly proved by the instances of wood being put into the hollows of mines, as props and supports to the roofs, which is found after a number of years as truly petrified as that which is dug up from the natural strata of the earth. In the pieces of petrified wood found in Germany, there are frequently veins of spar or of pure crystal, sometimes of earthy substances, and often of the matter of the common pebbles: these fragments of wood sometimes have the appearance of parts of the branches of trees in their natural state, but more frequently they resemble pieces of broken boards; these are usually capable of a high and elegant polish.

Many

Wood.

Many substances, it is certain, have been preserved in the cabinets of collectors, under the title of *petrified wood*, which have very little right to that name. But where the whole outer figure of the wood, the exact lineaments of the bark, or the fibrous and fistular texture of the striæ, and the vestiges of the utriculi and tracheæ or air-vessels, are yet remaining, and the several circles yet visible which denoted the several years growth of the tree, none can deny these substances to be real fossil wood. See PETRIFACTION.

Dr Parry of Bath has recently investigated the causes of the decay of wood, and the means of preventing it. For this purpose he recommends the application of a preparation of the resinous kind, mixed with a certain portion of bees-wax. The proportion of the ingredients and the mode of mixing them are as follows: Take 12 ounces of rosin and 8 ounces of roll brimstone, each coarsely powdered, and 3 gallons of train oil; beat them slowly, gradually adding 4 ounces of bees-wax, cut into small bits. Frequently stir the liquor, which, as soon as the solid ingredients are dissolved, will be fit for use. It is recommended to dress every part of the wood-work with this composition twice over before the parts are put together, and once afterwards; and a higher state of preservation is promised from its use than has yet been attained. It should be observed, that in preparing this varnish, it is advisable, in order to prevent accidents, to use an earthen vessel, and to make the fire in the open air.

WOOD (*sylva*), in *Ancient Geography*, a multitude of trees extended over a large continued tract of land, and propagated without culture. The generality of woods only consist of trees of one kind.—The ancient Saxons had such a veneration for woods, that they made them sanctuaries.—It is ordained, that none shall destroy any wood, by turning it into tillage or pasture, &c. where there are two acres or more in quantity, on pain of forfeiting 40s. an acre, by 35 Henry VIII. c. 17. All woods that are felled at 14 years growth, are to be preserved from destruction for eight years; and no cattle put into the ground till five years after the felling thereof, &c. 13 Eliz. c. 25. The burning of woods or underwood is declared to be felony; also those persons that maliciously cut or spoil timber-trees, or any fruit-trees, &c. shall be sent to the house of correction, there to be kept three months, and whipt once a month.

WOOD, *Engraving on*, is commonly executed on box; and in many cases, engravings of this kind are used with advantage instead of copperplates. The art of cutting or engraving on wood is of very high antiquity; for Chinese printing is a specimen of it. Even in Europe, if credit be due to Papillon, this art was practised at a very remote period; for he mentions eight engravings on wood, entitled, "A representation of the warlike actions of the great and magnanimous Macedonian king, the bold and valiant Alexander; dedicated, presented, and humbly offered, to the most holy father, Pope Honorius IV. by us Alexander Arberic Cunio Chevalier, and Isabella Cunio, &c." This anecdote, if true, carries the art of cutting in wood back to 1284 or 1285; for Honorius occupied the papal throne only during these two years. But this is not the remotest period to which some have carried the art in Europe: for the use of seals or signets being of very high antiquity, they imagine that the invention of wood-cuts must be coeval with them. The supposition is certainly plausible, but it is not supported by proof. The earliest impression of a wooden-cut, of which there is any certain account, is that of St Christopher carrying an infant Jesus through the sea, in which a hermit is seen holding up a lanthorn to shew him the way; and a peasant, with a sack on his back, climbing a hill, is exhibited in the back ground. The date of this impression is 1423. In the year 1430 was printed at Haerlem, "The history of St John the evangelist and his revelation, represented in 48 figures in wood, by Lowrent Janson Coster;" and, in 1438, Jorg Schappf of Augsburg cut in wood the history of the Apocalypse, and what was called *The poor man's bible*.

A folio chronicle, published 1493 by Shedal, was adorned with a great number of wooden-cuts by William Plydenwurff and Michael Wolgemut, whose engravings were greatly superior to any thing of the kind which had appeared before them. The latter was the preceptor of Albert Durer, whose admirable performances in this department of art are justly held in the highest esteem even at the present day.

About this period it became the practice of almost all the German engravers on copper to engrave likewise on wood; and many of their wood cuts surpass in beauty the impressions of their copperplates. Such are the wood-cuts of Albert Aldtorfer, Hisbel Pen, Virgil Soles, Lucas Van Cranach, and Lucas Van Leyden, the friend and imitator of Albert Durer, with several others.

The Germans carried this art to a great degree of perfection. Hans or John Holbein, who flourished in 1500, engraved the *Dance of Death*, in a series of wooden-cuts, which, for the freedom and delicacy of execution, have scarcely been equalled, and never surpassed. Italy, France, and Holland, have produced capital artists of this kind. Joan. Tornæsiom printed a bible at Leyden, in 1554, with wooden-cuts of excellent workmanship. Christopher Jegher of Antwerp, from his eminence in the art, was employed by Rubens to work under his inspection, and he executed several pieces which are held in much estimation; they are particularly distinguished for boldness and spirit.

The next attempt at improvement in this art was by Hugo da Carpi, to whom is attributed the invention of the *chiaro scuro*. Carpi was an Italian, and of the 16th century; but the Germans elaim the invention also, and produce in evidence several engravings by Mair, a disciple of Martin Schoen, of date 1499. His mode of performing this was very simple. He first engraved the subject upon copper, and finished it as much as the artists of his time usually did. He then prepared a block of wood upon which he cut out the extreme lights, and then impressed it upon the print; by which means a faint tint was added to all the rest of the piece, excepting only in those parts where the lights were meant to predominate, which appear on the specimens extant to be coloured with white paint. The drawings for this species of engraving were made on tinted paper with a pen, and the lights were drawn upon the paper with white paint.

But there is a material difference between the chiaro scuro of the old German masters and that of the Italians. Mair and Cranach engraved the outlines and deep

deep shadows upon copper. The impression taken in this state was tinted over by means of a single block of wood, with those parts hollowed out which were designed to be left white upon the print. On the contrary, the mode of engraving by Hugo da Carpi was, to cut the outline on one block of wood, the dark shadows upon a second, and the light shadows, or half-tint, upon a third. The first being impressed upon the paper, the outlines only appeared: this block being taken away, the second was put in its place, and being also impressed on the paper, the dark shadows were added to the outlines; and the third block being put in the same place upon the removal of the second, and also impressed upon the paper, made the dim tints, when the print was completed. In some instances, the number of blocks was increased, but the operation was still the same, the print receiving an impression from every block.

In 1698, John Baptist Michael Papillon practised engraving on wood with much success, particularly in ornamental foliage and flowers, shells, &c. In the opinion, however, of some of the most eminent artists, his performances are stiff and cramped. From that period the art of engraving on wood gradually degenerated, and may be said to have been wholly lost, when it was lately re-invented by Mr Bewick of Newcastle. This eminent artist was apprentice to Mr Bielby, a respectable engraver on metal. Mr Bielby, who was accustomed to employ his apprentices in engraving on wood, was much gratified with the performance of Thomas Bewick, and therefore advised him to prosecute engraving in that line. The advice was followed; and young Bewick inventing tools, even making them with his own hands, and sawing the wood on which he was to work into the requisite thickness, proceeded to improve upon his own discoveries, without assistance or instruction of any kind. When his apprenticeship expired, he went to London, where the obscure wood engravers of the time wished to avail themselves of his abilities, while they were determined to give him no insight into their art. During his apprenticeship, he received from the Society for the Encouragement of Arts, &c. a premium of considerable value for the best engraving on wood. The cut which obtained the premium was one of a series for an edition of Gay's Fables. Having remained some years in London, he returned to Newcastle, and entered into copartnership with his old master; and established his reputation as an artist by the publication of his admirable History of Quadrupeds. This was followed by his History of Birds, in 2 vols. The greater part of the volume on Quadrupeds, and the whole of the first volume of the work on Birds, was composed by Mr Bielby.

John Bewick, brother to Thomas, learned the art of him, and practised it for several years in London with great applause. His abilities, however, though respectable, were not, by the best judges, deemed so brilliant as his brother's; and owing to bad health, and the nature of his connection with the booksellers and others, he seems not to have advanced the art beyond the stage at which he received it. He died, some years ago, at Newcastle.

Mr Nesbit, who executed the admirable cuts from designs by Thornton, for an edition of Hudibras, as well as the cuts for editions of Shakespeare and Thomson's Seasons, and Mr Anderson, whose beautiful cuts adorn the poem entitled *Grove Hill*, have been the most successful of Thomas Bewick's pupils, who have appeared before the public as artists. It appears, that the method practised by the ancient engravers on wood, whose works are still admired, must have been different from that of Bewick and his pupils. What that method was seems to be altogether unknown. Papillon, who writes the best history extant of the art, guesses indeed in what manner the old engravers proceeded, so as to give to their works the spirit and freedom for which they are famed; but that his guesses are erroneous seems evident from the stiffness of his own works. The principal characteristic in the mechanical department of the productions of the ancient masters is the crossing of the black lines, which Papillon has attempted with the greatest awkwardness, though it seems to have been accomplished by them with so much ease, that they introduced it at random, even where it could add nothing to the beauty of the piece. In Bewick's method of working, this cross hatching is so difficult and unnatural, that it may be considered as impracticable. Mr Nesbit has indeed introduced something of it into two or three of his pieces; but so great was the labour, and so little the advantage of this improvement, if such it can be called, that probably it will not be attempted again.

The engravers of Bewick's school work on the end of the wood, which is cut across the trunk of the tree, in pieces of the proper thickness. As wood cuts are generally employed in the printer's press amidst a form of types, this thickness must be regulated by the height of the types with which they are to be used. The tools employed are nearly the same with those used in copperplate engraving, being only a little more deep, or lozenge, as engravers call it. They must have points of various degrees of fineness for the different purposes to which they are applied, some of them being so much rounded off at the bottom as to approach to the nature of a goodge, whilst others are in fact little chissels of various sizes. These chissels and goodges, to which every artist gives the shape which he deems most convenient, are held in the hand in a manner somewhat different from the tool of the engraver on copper, it being necessary to have the power of lifting the chips upwards with ease. To attempt a description of this in writing would be in vain; but it is easily acquired, we are told, by practice.

The pupils of the school of Bewick consider it as quite improper to speak of his invention as a revival of the ancient art. Some old prints, it is true, have the appearance of being executed in the same way with his; but others have certainly been done by a method very different. It is therefore not fair to appreciate the present art by what has been done, but by what may be done; and that remains yet to be shewn. The art is in its infancy; and those who are disposed to compare it with the art of engraving on copper, ought to look back to the period when copperplate engraving was of as recent invention as Bewick's method of engraving on wood. Marc Antonio, who engraved under the direction of the great painter Raphael, thought it no mean proof of his proficiency in his art, that he was able to imitate on copperplates the wood-cuts of Albert Durer; and Papillon is highly indignant that there should have been persons so very blind as to mistake the copies for the originals. If copper has its advantages over wood in point of delicacy and minuteness, wood has, in its turn, advantages not inferior in regard to strength and richness. Those prints which were executed under the auspices of Titian and Rubens, will always remain a monument of the spirit and vigour natural to wood-engraving; and if there be not found in them all the attention to chiaro scuro, which the present age demands, it must not be attributed either to defect in the art, or to want of abilities in the artists, but to the taste of the times, when chiaro scuro was little understood. It remains for some enterprising artist to shew that the vigour of the ancient art may be attained by the present one, and at the same time to add to that vigour those gradations of shade which are so much admired in good copperplates. As there seems to be a more perfect, or at least a more pleasant black produced by wood than by copperplate printing, and certainly a more perfect white (A), who will say that any intermediate shade whatever may not be produced by wood cuts? To attempt this on a small scale would indeed be vain, because the slightest variation, produced by a little more or less ink, or a harder pressure in printing, bears such a proportion to a very short line, as must necessarily render the attempt abortive.

Wood-engraving, therefore, must always appear to disadvantage while it is confined to small subjects, and will never reach its station *as a fine art*, till those who are engaged in its cultivation improve upon the discoveries of one another, and apply to subjects to which it is properly adapted. As an *economical art* for illustrating mechanics, various branches of natural history, and other subjects of science, it is too little employed even in its present state.

The works of Bewick and his pupils, which have hitherto been published, are not numerous. Besides his quadrupeds and birds, the Hudibras, and the cuts for some editions of Shakespeare and Thomson's Seasons, by Nesbit, and the Grove Hill by Anderson, already noticed, there are also some others of less note.—Goldsmith's Traveller and Deserted Village with elegant plates, are all executed by Thomas Bewick, except one or two which were executed by John; Somerville's Chace by the same artists, executed in a style of elegance which perhaps has never been surpassed; a View of St Nicholas's Church, Newcastle, 15 inches long, by Mr Nesbit, who received for it a silver medal from the Society for the Encouragement of Arts.

Wood, Rotten, Illumination of. This is a subject which has often been discussed by naturalists. Spallanzani maintained, that there is a perfect analogy between the illumination of rotten wood, and artificial phosphorus; and he imagines, that in the putrid fermentation, the hydrogen and the carbone of the wood come more easily in contact with the oxygen of the atmosphere, by which combination a slow combustion, and the illumination of the wood, is produced; and he thinks that this process cannot proceed in the irrespirable kinds of gases. Rotten wood also, in which the necessary quantity of hydrogen and carbone is not at the same time disengaged, does not obtain the property of illuminating. Mr Corradori, however, objects to this theory, that the slow combustion does not take place according to the above theory, as the wood, at the time when it begins to illuminate, is mostly deprived of its resinous particles, and consequently contains but very little hydrogen and carbone; and it appears to him more probable, that the more it loses of combustible matter, the more it obtains the property of illuminating. There is, he thinks, a very great difference between this natural and the artificial phosphorus. Mr Humboldt concludes, from his experiments, that the illumination of rotten wood takes place only when it gets into contact with oxygen; and when it has lost the property of emitting light in irrespirable gases, it recovers it again by exposing it to oxygen gas. Dr Gartner, however, is of opinion, that, according to his experiments, a certain degree of humidity is always requisite, and he thinks that oxygen gas is not quite necessary though the illumination be increased by it. This phenomenon, however, being so very different from all known processes of combustion, where light is disengaged, Dr Gartner asks, whether it be not more agreeing with the animal process of respiration, than with a true combustion, or whether the illumination of the wood be produced by phosphorus and carbone in a proportion hitherto unknown. Dr Gartner is, on the whole, inclined to think, that it is at present impossible to give a satisfactory explanation of all the phenomena that occur in this process. Beckmann has made numerous experiments on the illumination of rotten wood, in different gases and fluids, in order to throw some light on the ideas of the above naturalists. The results of these experiments differ in some points from what the experiments of those gentlemen have shewn, which, however, Beckmann ascribes to the nature of rotten wood, as a substance that is not always of the same kind, and has not always an equal degree of putrefaction and humidity. It seems also to differ materially from the artificial phosphorus in the following particulars. 1. It shines in oxygen gas at a very low temperature. 2. It emits light in all irrespirable gases, at least for a short time. 3. In muriatic acid gas its light is suddenly extinguished. 4. It shines in a less degree in air rarefied by the air-pump. 5. According to Mr Corradori, it even shines in the torricellian vacuum. 6. Its illumination is extinguished in oxygen gas, as well as in other kinds of gases, when they are heated. 7. By its illumination in oxygen gas, carbonic acid gas is produced. 8. One may suffer the rotten wood to be extinguished several times, one after another, in irrespirable gases, without depriving them of the property of making new pieces of rotten wood shine again. 9. Humidity greatly promotes the illumination, and even seems to be necessary in producing it. 10. The rotten wood continues to shine under water, oil, and other fluids, and in some of them its light is even increased. All this seems to shew, that the extinction of rotten wood, in different media, does not immediately depend on a want of oxygen, but rather on a particular change, to which the wood itself has been exposed.

Wood-Cock. See Scolopax, Ornithology *Index*.

Wood-Goat. See Capra, Mammalia *Index*.

Wood-Louse. See Oniscus, Entomology *Index*.

(A) The parts of the print intended to be white are not even touched by the wood block.

Wood-Pecker
Woodmote
Woodstock.

Wood-Pecker. See Picus, Ornithology *Index*.

WOODMOTE. See *Forest Courts*.

WOODSTOCK, a town of Oxfordshire, in England, pleasantly seated on a rising ground, and on a rivulet; a well compacted borough-town, and sends two members to parliament; but is chiefly noted for Blenheim-house, a fine palace, built in memory of the victory obtained by the duke of Marlborough over the French and Bavarians in August 1704. It was erected at the public expence, and is one of the noblest seats in Europe. One of the passages to it is over a bridge with one arch, 190 feet in diameter, resembling the Rialto at Venice. The gardens take up 100 acres of ground; and the offices, which are very grand, have room enough to accommodate 300 people. The apartments of the palace are magnificently furnished; and the staircases, statues, paintings, and tapestry, surprisingly fine. The town is about half a mile from the palace, having several good inns; and a manufacture of steel chains for watches, and excellent gloves. A steel chain has been made at this place which sold for 170l.—The population in 1811 was 1419 persons. It is eight miles north of Oxford, and 60 west-north-west of London. W. Long. 1. 30. N. Lat. 51. 52.

WOODWARD, Dr John, was born in 1665, and educated at a country school, where he learned the Latin and Greek languages, and was afterwards sent to London, where he is said to have been put apprentice to a linen-draper. He was not long in that station, till he became acquainted with Dr Peter Barwick, an eminent physician, who took him under his tuition and into his family. Here he prosecuted with great vigour and success the study of philosophy, anatomy, and physic. In 1692, Dr Stillingfleet quitting the place of professor of physic in Gresham college, our author was chosen to succeed him, and the year following was elected F. R. S. In 1695 he obtained the degree of M. D. by patent from Archbishop Tennison; and the same year he published his Essay towards a Natural History of the Earth. He afterwards wrote many other pieces, which have been well received by the learned world. He founded a lecture in the university of Cambridge, to be read there upon his Essay, &c. and handsomely endowed it. He died in 1728.

WOOF, among manufacturers, the threads which the weavers shoot across with an instrument called the *shuttle*. See Cloth.

WOOKEY or *Okey Hole*, a remarkable cavern two miles from the city of Wells in Somersetshire; for an account of which, see the article Grotto.

WOOL, the covering of sheep. See Ovis and Sheep.

Wool resembles hair in a great many particulars; but besides its fineness, which constitutes an obvious difference, there are other particulars which may serve also to distinguish them from one another. Wool, like the hair of horses, cattle, and most other animals, completes its growth in a year, and then falls off as hair does, and is succeeded by a fresh crop. It differs from hair, however, in the uniformity of its growth, and the regularity of its shedding. Every filament of wool seems to keep exact pace with another in the same part of the body of the animal; the whole crop springs up at once; the whole advances uniformly together; the whole loosens from the skin nearly at the same period, and thus falls off, if not

See, vol. viii. p. 57.

Wool.

previously shorn, leaving the animal covered with a short coat of young wool, which in its turn undergoes the same regular mutations.

Hairs are commonly of the same thickness in every part; but wool constantly varies in thickness in different parts, being generally thicker at the points than at the roots. That part of the fleece of sheep which grows during the winter is finer than what grows in summer. This was first observed by Dr Anderson, the editor of the Bee, and published in his *Observations on the Means of exciting a Spirit of National Industry*.

While the wool remains in the state it was first shorn off the sheep's back, and not sorted into its different kinds, it is called *fleece*. Each fleece consists of wool of divers qualities and degrees of fineness, which the dealers therein take care to separate. The French and English usually separate each fleece into three sorts, viz. 1. Mother-wool, which is that of the back and neck. 2. The wool of the tails and legs. 3. That of the breast and under the belly. The Spaniards make the like division into three sorts, which they call *prime*, *second*, and *third*; and for the greater ease, mark each bale or pack with a capital letter, denoting the sort. If the triage or separation be well made, in 15 bales there will be 12 marked R, that is, refine, or prime; two marked F, for fine, or second; and one S, for thirds.

The wools most esteemed are the English, chiefly those about Leominster, Cotswold, and the isle of Wight; the Spanish, principally those about Segovia; and the French, about Berry: which last are said to have this peculiar property, that they will knot or bind with any other sort; whereas the rest will only knot with their own kind.

Among the ancients, the wools of Attica, Megara, Laodicea, Apulia, and especially those of Tarentum, Parma, and Altino, were most valued. Varro assures us, that the people there used to clothe their sheep with skins, to secure the wool from being damaged.

Of late a great deal of attention has been paid to wool in this country, as well as several others. Several very spirited attempts have been made to improve it, by introducing superior breeds of sheep, and better methods of managing them. For this purpose has been formed the

British Wool Society, an association formed for the purpose of obtaining the best breeds of fine-woolled sheep, with a view of ascertaining, by actual experiments, how far each species or variety is calculated for the climate of Great Britain; the qualities of their wool respectively; the uses to which each kind of wool could be most profitably employed in different manufactures; and the comparative value of each species of sheep, so far as the same can be determined.

Attention had for some time been paid by the Highland Society to a famous breed of fine-woolled sheep in Shetland; but it occurred to Sir John Sinclair of Ulbster, baronet, and to Dr James Anderson, well known as the author of many useful publications, that the improvement of British wool was a matter of too much importance to be entrusted to a society which is obliged to devote its attention to such a variety of objects as the general improvement of the Highlands of Scotland. The latter of these gentlemen, therefore, in an Appendix to the Report of the Committee of the Highland

 Society

Wool. Society of Scotland, for the year 1790, proposed *the plan of a patriotic association for the improvement of British wool;* and the former, who was convener of the committee to whom the subject of Shetland wool had been referred, wrote circular letters, recommending the plan. The consequence of which was, that on the 31st of January 1791, several noblemen and gentlemen of the highest respectability met in Edinburgh, and constituted themselves into a *Society for the Improvement of British Wool.* Of this society Sir John Sinclair was elected president; after which, in an excellent speech, he pointed out to the members the objects of the institution, the means by which those objects could be attained, and the advantages which would result from their united labours. This address was afterwards printed by order of the society.

The particular breeds of sheep to which the society proposed to direct its attention, were sheep for the hilly parts of Scotland; sheep for the plains, or the Lowland breed; and sheep for the islands. They were to try experiments also with sheep from foreign countries, distinguished by any particular property.

The principal objects which the members had in view, during the first year of their association, were, 1. To collect specimens of the best breeds which Great Britain at that period afforded, in order to ascertain the degree of perfection to which sheep had already been brought in this kingdom. 2. To procure from every country, distinguished for the quality of its sheep and wool, specimens of the different breeds it possessed, in order to ascertain how far the original breed, or a mixed breed from it and the native sheep of the country, could thrive in Scotland. 3. To disperse as much as possible all these breeds, both foreign and domestic, over the whole kingdom, wherever proper persons could be found to take charge of them, in order to try experiments on a more extensive scale than the society itself could do; to spread information, and to excite a spirit for the improvement of sheep and wool in every part of the country.

Sir John Sinclair had previously collected a flock, consisting of sheep of the Spanish, Herefordshire, Southdown, Cheviot, Lomond hills, and Shetland breeds, and of a mixed breed from these different sheep. This flock amounted to 110 rams, ewes, and lambs. M. d'Aubenton, in consequence of a correspondence with Sir John Sinclair, sent over to the society ten rams and five ewes, of real Spanish breed, which had been originally entrusted to his care by the late king of France: these, after encountering a number of obstacles, and after being stopped and threatened to be slaughtered at the customhouse of Brighthelmstone for the use of the poor, arrived safe at Leith. Lord Sheffield, at the same time, sent to the society four rams and six ewes of the Southdown and Spanish breeds. Mr Bishton of Kilsall, in Shropshire, presented them with three Hereford rams, reckoned by many the best breed in England; the society at the same time ordered 150 ewes of the same breed, and two ewes of the Long Mountain breed, reckoned the best in Wales, to be sent along with them. They purchased 57 rams and 173 ewes of the Cheviot breed, reckoned the best in Scotland, for the hilly parts of the country. Lord Daer sent them 20 ewes of an excellent breed, which existed at Mochrum in Galloway. The late earl of Oxford sent them in a present three rams of the Norfolk crossed by the Cape of Good Hope breed. Mr Isaac Grant junior of Leghorn, in conjunction with Mr Sibbald, merchant at Leith, presented them an Apulian ram and ewe; the ram arrived in safety, but the ewe unfortunately died on the passage. Mr Baron Seton of Preston, in Linlithgowshire, sent them a ram and two ewes of a Spanish breed, which had been for some time kept in Sweden unmixed with any other. They purchased 100 ewes of a small breed existing in the parish of Leuchars in Fife, much resembling the Shetland. The Right Honourable William Conynghame of Ireland sent them 11 Spanish rams, seven Spanish ewes, 15 three-fourth breed and 16 one-half breed Spanish and Irish ewes. Lord Sheffield sent them eight rams and 18 ewes; and his majesty made them a present of two rams.

Thus, in the course of one year, the society acquired by donation or purchase about 800 sheep of different sorts and ages, and many of them from foreign countries: about 500 of these were distributed over different parts of Scotland, the greater number of which were sold to gentlemen anxious to promote the views of the society, and well qualified to make experiments on the different breeds which they had obtained. The greatest part of the remainder were taken by different gentlemen, who kept them for the society, and according to their directions, without any expence.

It is impossible to produce an instance of so much having been accomplished by a society of private individuals in so short a time. Nor was this all; the same year Mr Andrew Kerr, a very intelligent sheep-farmer on the borders of England, was sent, at the expence of the society, to examine the state of sheep-farming along the east coast of Scotland and the interior parts of the Highlands. His tour was printed by order of the society, and contains the first intimation of the possibility of the Cheviot breed thriving in the north of Scotland.

In the year 1792, Messrs Redhead, Laing, and Marshall were sent by the society, to make a survey of the state of sheep-farming through some of the principal counties of England; the result of which was also published by the society, and contains more information on the subject of the different breeds of England than any work hitherto published; and in 1794, Mr John Naismyth was sent on a tour through the southern districts of Scotland, which completed the circuit of almost the whole kingdom.

Thus a few private individuals, unaided by the public purse, had boldness enough to undertake ascertaining the comparative value of the different kinds of sheep in their own country, and to introduce some of the most celebrated breeds of other countries, and succeeded in the spirited attempt. It is impossible in this place to state more minutely the various other transactions of the society; to enter into any detail of the premiums given by this respectable institution for the improvement of the celebrated Shetland breed; or to explain how, as if it were by magic, in a country where the manufacture of wool was little known, articles manufactured of that material were made, rivalling, and in some cases surpassing, the most celebrated fabrics of other countries. A war having unfortunately arisen, it became impossible to pay the same attention, or to carry on with the same success, novel enterprises; even old

Wool, Wool-combing.

old establishments often fall a sacrifice amidst the horrors of war. The utmost that the British Wool Society could expect to do, was to preserve the institution in such a state, that when peace shall be happily restored it may revive with double energy and spirit.

It is a curious fact that the Romans, during their residence in Britain, established a manufactory of woollen cloth at Winchester, which was so extensive as to supply their army; and there is reason to believe that the trade which they introduced into Britain, was not neglected by the native inhabitants, for the first 900 years of the Christian era. The long Spanish wool was imported into this country so early as the 12th century, and we find that since the days of Edward III. British fleeces were admirably adapted to the kind of cloth which was in greatest request, though now they are generally unequal to the production of that which is sought after.

Wool-Combing, a well known operation, which, when performed by the hand, is laborious, tedious, and expensive. The expence of it through all England has been calculated at no less a sum than 800,000l.; and to lessen this expence, the Rev. Edmund Cartwright of Doncaster in Yorkshire bethought himself, some years ago, of carding wool by machinery. After repeated attempts and improvements, for which he took out three patents, he found that wool can be combed in perfection by machinery, of which he gives the following description.

Plate DLXXVIII. fig. 1.

Fig. 1. is the crank lasher. A is a tube through which the material, being formed into a sliver, and slightly twisted, is drawn forward by the delivering rollers; B, a wheel fast upon the cross bar of the crank; C, a wheel, on the opposite end of whose axis is a pinion working in a wheel upon the axis of one of the delivering rollers.

Note. When two or more slivers are required, the cans or baskets, in which they are contained, are placed upon a table under the lasher (as represented at D), which, by having a slow motion, twists them together as they go up.

Fig. 2. Fig. 3.

Fig. 2. is the circular clearing comb, for giving work in the head, carried in a frame by two cranks. Fig. 3. the comb-table, having the teeth pointing towards the centre, moved by cogs upon the rim, and carried round upon trucks like the head of a windmill. *a*, *b*, The drawing rollers. *c*, *d*, Callendar, or conducting rollers.

Note. Underneath the table is another pair of rollers, for drawing out the backings.

In the above specification, we have omitted the frame in which the machine stands, the wheels, shafts, &c. Had these been introduced, the drawing would have been crowded and confused; besides, as matters of information, they would have been unnecessary, every mechanic, when he knows the principles of a machine, being competent to apply the movements to it.

The wool, if for particularly nice work, goes through three operations, otherwise two are sufficient: the first operation opens the wool, and makes it connect together into a rough sliver, but does not clear it. The clearing is performed by the second, and, if necessary, a third operation. A set of machinery, consisting of three machines, will require the attendance of an overlooker and ten children, and will comb a pack, or 240lb. in twelve hours. As neither fire nor oil is necessary for machine-combing, the saving of those articles, even the fire alone, will, in general, pay the wages of the overlooker and children; so that the actual saving to the manufacturer is the *whole* of what the combing costs, by the old imperfect mode of hand-combing. Machine-combed wool is better, especially for machine-spinning, by at least 12 per cent. being all equally mixed, and the slivers uniform, and of any required length.

Wool-combing ‖ Worcester.

WOOLSTON, Thomas, an English divine, was born at Northampton in 1669, and educated at Cambridge. His first appearance in the learned world was in 1705, in a work entitled, The Old Apology for the Truth of the Christian Religion, against the Jews and Gentiles, revived. He afterwards wrote many pieces: but what made the most noise, were his six Discourses on the Miracles of Christ; which occasioned a great number of books and pamphlets upon the subject, and raised a prosecution against him. At his trial in Guildhall, before the lord chief justice Raymond, he spoke several times himself; and urged, that "he thought it very hard that he should be tried by a set of men who, though otherwise very learned and worthy persons, were no more judges of the subjects on which he wrote, than himself was a judge of the most crabbed points of the law." He was sentenced to a year's imprisonment, an to pay a fine of 100l. He purchased the liberty of the rules of the King's bench, where he continued after the expiration of the year, being unable to pay the fine. The greatest obstruction to his deliverance from confinement was, the obligation of giving security not to offend by any future writings, he being resolved to write again as freely as before. Whilst some supposed that this author wrote with the settled intention of subverting Christianity under the pretence of defending it, others believed him disordered in his mind; and many circumstances concurred which gave countenance to this opinion. He died, January 27. 1732-3, after an illness of four days; and, a few minutes before his death, uttered these words: "This is a struggle which all men must go through, and which I bear not only patiently, but with willingness." His body was interred in St George's church-yard, Southwark.

WOOLWICH, a town in Kent, with a market on Fridays. It is seated on the river Thames, and of great note for its fine docks and yards, where men of war are built; as also for its vast magazines of great guns, mortars, bombs, cannon-balls, powder, and other warlike stores. It has likewise an academy, where young officers are instructed in the military art; the population in 1801 exceeded 9000. It is nine miles east of London. E. Long. 0. 10. N. Lat. 51. 30.

WORCESTER, in Latin *Wigornia*, the capital of a county of England of the same name, stands on the river Severn, but so low that it can hardly be seen till one is close upon it. It is supposed to be the Branonium of Antoninus, the Branogenium of Ptolemy, and to have been built by the Romans to awe the Britons on the other side of the Severn. It was made an episcopal see about the year 680 by Sexulphus bishop of the Mercians; but the present cathedral was begun by Wulston in the year 1084. The town hath been several times burnt down; first, in 1041, by Hardicanute, who also massacred the citizens; secondly, not long after William Rufus's time; and a third time, when King Stephen besieged and took it. Here, in latter times, was

Worcester. was fought that battle, in which Charles II. with his Scots army, was defeated by Cromwell. In a garden near the south gate of the city, where the action was hottest, the bones of the slain are often dug up. It had formerly strong walls and a castle; but these have been demolished long ago. It is now a large city, the streets broad and well paved, and some of them very regular and well built, particularly Foregate-street; so that in general it is a very agreeable place. The cathedral is a stately edifice, and among other monuments in it are those of King John, of Arthur, elder brother to Henry VIII. and of the countess of Salisbury, who gave occasion to the institution of the order of the Garter. There are seven or eight hospitals in and about the city; of which that built and endowed by Robert Berkley of Spetchley, Esq. is a very noble one. There is a school founded by Henry VIII. three other schools, and six charity-schools. The churches, St Nicholas and All-Saints, have been lately rebuilt, and are handsome edifices. The city carries on a great trade; for which it is chiefly indebted to its situation upon the Severn. The population in 1801 was estimated at 11,000, a large proportion of which is employed in the manufacture of broad cloth and gloves. The Welch inhabit a part of it, and speak their own language. Its market is well supplied with provisions and cattle, and its quay is much frequented by ships. By a charter from James I. it is governed by a mayor, six aldermen who are justices of the peace, and chosen out of 24 capital citizens; a sheriff, the city being a county of itself; a common council, consisting of 48 other citizens, out of which two chamberlains are yearly chosen; a recorder, town-clerk, two coroners, a sword-bearer, 13 constables and four serjeants at mace. Of the bishops of this see, there have been, it is said, one pope, four saints, seven lord high chancellors, 11 archbishops, two lord treasurers, one chancellor to the queen, one lord president of Wales, and one vice-president. The city at present gives title of earl and marquis to the duke of Beaufort. W. Long. 1. 55. N. Lat. 52. 10.

WORCESTER, *Edward Somerset, Marquis of*, was a distinguished political character in the time of Charles I. by whom he was created earl of Glamorgan, while heir apparent to the marquis of Worcester. This nobleman flourished chiefly in the reign of Charles I. and seems to have been a most zealous adherent to the cause of that unfortunate monarch, on whose account it is said that he and his father wasted an immense sum. Of this the king was so sensible, that he granted to the earl a most extraordinary patent, the chief powers of which were, to make him generalissimo of three armies, and admiral with nomination of his officers; to enable him to raise money by selling his majesty's woods, wardships, customs, and prerogatives; and to create by blank patents, to be filled up at Glamorgan's pleasure, from the rank of marquis to baronet. If any thing, says Lord Orford, could justify the delegation of such authority, besides his majesty having lost all authority, when he conferred it, it was the promise with which the king concluded, of bestowing the princess Elizabeth on Glamorgan's son. This patent was given up by the marquis to the house of peers after the restoration. He died not long after that era, in 1667, after he had published what Lord Orford calls the following amazing piece of folly.

"A century of the names and scantlings of such inventions, as at present I can call to mind to have tried and perfected, which (my former notes being lost) I have, at the instance of a powerful friend, endeavoured now in the year 1655, to set these down in such a way as may sufficiently instruct me to put any of them in practice."

Some of the inventions referred to in this work are the following. A ship-destroying engine, a coach-stopping engine, a balance water-work, a bucket fountain, an ebbing and flowing castle clock, a tinder-box pistol, a pocket ladder, a most admirable way to raise weights, a stupendous water-work. For the last contrivance the marquis procured an act of parliament in 1663, for the sole benefit arising from it, one-tenth of it being appropriated to Charles II. and his successors.

In a manuscript addition to a copy of the Century of Inventions, the stupendous or water-commanding engine is described as boundless for height or quantity, requiring no external, or even additional help or force to be set or continued in motion, but what intrinsically is afforded from its own operation, nor yet the twentieth part thereof, and the engine consisteth of the following particulars. 1. A perfect counterpoise for what quantity soever of water. 2. A perfect countervail, for what height soever it is to be brought unto. 3. A primum mobile, commanding both height and quantity, regulator-wise. 4. A vicegerent or countervail, supplying the place, and performing the full force of man, wind, beast, or mill. 5. A helm or stern, with bit and reins, wherewith any child may guide, order, and controul the whole operation. 6. A particular magazine for water, according to the intended quantity or height of water. 7. A place for the original fountain, or even river to run into, and naturally of its own accord incorporate itself with the rising water and at the very bottom of the same aqueduct, though never so big or high.

Various and very opposite opinions have been held with regard to the title of this nobleman to be considered as a mechanical genius. Lord Orford has pronounced his work an amazing piece of folly; and Mr Hume, speaking of his political conduct, says, "That the king judged aright of this nobleman's character, appears from his Century of Arts, or Scantling of inventions, which is a ridiculous compound of lies, chimeras, and impossibilities, and shows what might be expected from such a man." *Hist. of England.* It may be fairly presumed from the quotations now made, that neither Lord Orford nor Mr Hume was qualified to judge of the marquis's work, otherwise a more temperate or a more modified opinion would have been given. By others, the author of the inventions has been regarded as one of the greatest mechanical geniuses, and is to be considered as the inventor of the steam-engine, which he denominates a stupendous water-work. There seems to be no reason to suppose that any steam-engine was erected by the marquis himself; but it is said that Captain Savary, after reading the marquis's books, tried many experiments upon the power and force of steam, and at last fell upon a method of applying it to raise water; and having bought up and destroyed all the marquis's books that could be got, claimed the honour of the invention to himself, and obtained a patent for it.

The

The marquis of Worcester is sometimes confounded with John Tiptoft, earl of Worcester, a very accomplished literary character, who lived in the times of Henry VI. and Edward IV. Being attached to Edward, he absconded during the short restoration of Henry, and being taken concealed in a tree in Waybridge forest in Huntingdonshire, he was brought to London, accused of cruelty in his administration of Ireland, and condemned and beheaded at the Tower in the year 1470. This nobleman translated Cicero de Amicitia, some parts of Cæsar's Commentaries, and was the author of several other works.

WORCESTERSHIRE, a county of England, bounded by Warwickshire on the east, by Gloucestershire on the south, by the counties of Hereford and Salop on the west, and on the north by Staffordshire. According to Templeman, it is 36 miles in length, 28 in breadth, and about 130 in circumference, within which it contains seven hundreds, and a part of two others, 11 market towns, of which three are boroughs, one city, namely *Worcester*, 152 parishes, about 540,000 acres, and in 1811, 160,546 inhabitants.

This being an inland county, well cultivated, and free from lakes, marshes, or stagnant waters, the air is very sweet and wholesome all over it. The soil in general is very rich, producing corn, fruit, especially pears, of which they make a great deal of perry; hops and pasture. The hills are covered with sheep, and the meadows with cattle. Hence they have wool, cloth, stuffs, butter, and cheese in abundance. They are also well supplied with fuel, either wood or coal, and salt from their brine pits and salt springs. Of the last they have not only enough for themselves, but export large quantities by the Severn; which noble river, to the great convenience and emolument of the inhabitants, runs from north to south through the very middle of the county, enriching the soil, and yielding it plenty of fish, and an easy expeditious conveyance of goods to and from it. It is also watered by the Stour, Avon, Teme, &c. It sends nine members to parliament, viz. two for the county, two for the city of Worcester, two for Droitwich, two for Evesham, and one for Bewdley; and lies in the diocese of Worcester, and Oxford circuit. See WORCESTERSHIRE, SUPPLEMENT.

WORD, in language, an articulate sound designed to represent some idea or notion. See GRAMMAR and LANGUAGE. See also LOGIC, Part I. chap. i.

WORD, or *Watch-word*, in military affairs, is some peculiar word or sentence, by which the soldiers know and distinguish one another in the night, &c. and by which spies and designing persons are discovered. It is used also to prevent surprises. The word is given out in an army every night to the lieutenant or major-general of the day, who gives it to the majors of the brigades, and they to the adjutants; who give it first to the field-officers, and afterwards to a serjeant of each company, who carry it to the subalterns. In garrisons it is given after the gate is shut to the town-major, who gives it to the adjutants, and they to the serjeants.

WORDS of Command. See EXERCISE and MANUAL.

Signals by the Drum, made use of in exercising of the Army, instead of the WORD of Command, viz.

Signals by the drum.	*Operations.*
A short roll,	To caution.
A flam,	To perform any distinct thing.
To arms,	To form the line or battalion.
The march,	To advance, except when intended for a salute.
The quick march,	To advance quick.
The point of war,	To march and charge.
The retreat,	To retreat.
Drum ceasing,	To halt.
Two short rolls,	To perform the flank firing.
The dragoon march,	To open the battalion.
The grenadier march,	To form the column.
The troop,	To double divisions.
The long roll,	To form the square.
The grenadier march,	To reduce the square to the column.
The preparative,	To make ready and fire.
The general,	To cease firing.
Two long rolls,	To bring or lodge the colours.

WORK, in the manege. To work a horse, is to exercise him at pace, trot, or gallop, and ride him at the manege. To work a horse upon volts, or head and haunches in or between two heels, is to passage him, or make him go sideways upon parallel lines.

To WORK, in sea language, is to direct the movements of a ship, by adapting the sails to the force and direction of the wind. See SEAMANSHIP.

WORK, Carpenters, Clock, Crown, Field, Fire, Fret, Grotesque, Horn, Mosaic. See the several articles, together with FORTIFICATION and PYROTECHNY.

WORK-House, a place where indigent, vagrant, and idle people, are set to work, and supplied with food and clothing.

Work-houses are of two kinds, or at least are employed for two different purposes. Some are used as prisons for vagrants or sturdy beggars, who are there confined and compelled to labour for the benefit of the society which maintains them; whilst others, sometimes called *poor-houses*, are charitable asylums for such indigent persons as through age or infirmity are unable to support themselves by their own labour. The former kind of work-house, when under proper management, may be made to serve the best of purposes; of the latter we are acquainted with none which entirely commands our approbation.

To make confinement in a work-house operate to the correction of vagrants and disorderly persons (and if it produce not this effect it can hardly be considered as a beneficial institution), the prisoners should be shut up in separate cells, and compelled to labour for their own subsistence. A crew of thieves and vagabonds associating with each other is a hell upon earth, in which every individual is hardened in his crimes by the countenance and conversation of his companions; and wretches who, when at liberty, choose to beg or steal rather than to earn a comfortable livelihood by honest industry, will submit to any punishment which a humane overseer can inflict rather than work for the benefit of others. No punishment indeed will compel a vagrant to labour. He may assume the appearance of it, but he will make no progress; and the pretext of sickness or weakness is ever at hand for an excuse. Hence it is that thieves and

Work-house.

strumpets are too often dismised from work-houses and bridewells ten times more the children of the devil than when they entered them.

To remedy these evils, we can think of no better method than to confine each prisoner in a cell by himself, and to furnish him daily with such an allowance of bread and water as may preserve him from *immediate* death; for the only compulsion to make such men work seriously is the fear of want, and the only way to reform them is to leave them to their own meditations on the consequences of their past conduct. There are surely very few persons, if any, whose aversion from labour would not be conquered by the pinchings of hunger and the certain prospect of perishing by famine; and it is to be hoped that there are not many so totally divested of every latent principle of virtue, as not to be brought by such solitude to a due sense of their former wickedness. Should one or two, however, be occasionally found so very obdurate as to suffer themselves to perish rather than work, their deaths would prove a salutary beacon to others, and their blood would be on their own heads; for we have the express command of St Paul himself, that "if any will not work, neither should he eat."

No doubt it would be proper that the meditations of vagabonds confined in a work-house should be directed by the private admonitions of a pious and intelligent clergyman; but it is not every clergyman who is qualified to discharge such a duty. If he be actuated by a zeal not according to knowledge, or if he have not with equal care studied human nature and the word of God, his admonitions will be more likely to provoke the profane ridicule of his auditor, and harden him in his wickedness, than to excite in his breast such sorrow for his sins as shall "bring forth fruits meet for repentance." To render the instruction of thieves and vagrants of any use, it must be accurately adapted to the case of each individual; and however excellent it may be in itself, it will not be listened to unless offered at seasons of uncommon seriousness, which the instructor should therefore carefully observe.

That such wholesome severity as this would often reform the inhabitants of work-houses, appears extremely probable from the effects of a similar treatment of common prostitutes mentioned by Lord Kames in his Sketches of the History of Man: "A number of those wretches were in Edinburgh confined in a house of correction, on a daily allowance of threepence, of which part was embezzled by the servants of the house. Pinching hunger did not reform their manners; for being absolutely idle, they encouraged each other in vice, waiting impatiently for the hour of deliverance. Mr Stirling the superintendant, with the consent of the magistrates, removed them to a clean house; and, instead of money, appointed for each a pound of oatmeal daily, with salt, water, and fire for cooking. Relieved now from distress, they longed for comfort. What would they not give for milk or ale? Work (says he) will procure you plenty. To some who offered to spin, he gave flax and wheels, engaging to pay them half the price of their yarn, retaining the other half for the materials furnished. The spinners earned about ninepence weekly; a comfortable addition to what they had before. The rest undertook to spin, one after another; and before the end of the first quarter they were all of them intent upon work. It was a branch of his plan to set free such as merited that favour; and some of them appeared to be so thoroughly reformed as to be in no danger of a relapse."

Work-houses erected as charitable asylums appear to us, in every view that we can take of them, as institutions which can serve no good purpose. Economy is the great motive which inclines people to this mode of providing for the poor. There is comparatively but a very small number of mankind in any country so aged and infirm as not to be able to contribute, in some degree, to their subsistence by their own labour; and in such houses it is thought that proper work may be provided for them, so that the public shall have nothing to give in charity but what the poor are absolutely unable to procure for themselves. It is imagined likewise, that numbers collected at a common table, can be maintained at less expence than in separate houses; and foot soldiers are given for an example, who could not live on their pay if they did not mess together. But the cases are not parallel. "Soldiers having the management of their pay, can club for a bit of meat; but as the inhabitants of the poor-house are maintained by the public, the same quantity of provisions must be allotted to each. The consequence is what might be expected: the bulk of them reserve part of their victuals for purchasing ale or spirits. It is vain to expect work from them: poor wretches void of shame will never work seriously, where the profit accrues to the public, not to themselves. Hunger is the only effectual means for compelling such persons to work *."

* Lord Sketches

The poor, therefore should be supported in their own houses; and to support them properly, the first thing to be done is, to estimate what each can earn by his own labour; for as far only as that falls short of maintenance, is there room for charity. In repairing those evils which society did not or could not prevent, it ought to be careful not to counteract the wise purposes of nature, nor to do more than to give the poor a fair chance to work for themselves. The present distress must be relieved, the sick and the aged provided for; but the children must be instructed; and labour, not alms, offered to those who have some ability to work, however small that ability may be. They will be as industrious as possible, because they work for themselves; and a weekly sum of charity under their own management will turn to better account than in a poor-house under the direction of mercenaries. Not a penny of it will be laid out on fermented liquors, unless perhaps as a medicine in sickness. Nor does such low fare call for pity to those who can afford no better. Ale makes no part of the maintenance of those who, in many parts of Scotland, live by the sweat of their brows; and yet the person who should banish ale from a charity work-house, would be exclaimed against as hard-hearted, and even void of humanity.

That such a mode of supporting the poor in their own houses is practicable, will hardly admit of a dispute; for it has been actually put in practice in the city of Hamburgh ever since the year 1788. At that period such revenues as had till then been expended in alms by the several church-wardens, and those of which the administration had been connected with the work-house, were united under one administration with such sums as were collected from private benevolence. The city was divided into sixty districts, containing each an equal

equal number of poor; and over these 180 overseers were appointed. Actual relief was the first object; but at the very moment that this provision was secured, measures were taken to prevent any man from receiving a shilling which he could have been able to earn for himself. By these methods, which our limits will not permit us to state, the overseers were able to make a calculation tolerably exact of what each pauper wanted for bare subsistence, in addition to the fruits of his own labour. A flax-yarn-spinning manufacture was established, in which the yarn is paid for, not by its weight, but by its measure. The clean flax is sold to the poor at a low price, and a certain measure of yarn again bought from them at 30 per cent. above the usual price; so that the overseers are sure that all the yarn spun by the poor will be brought into their office. Every pauper brings with him a book in which the quantity delivered is carefully noted down, which furnishes the overseers with a continual average of the state of industry among their poor.

As soon as this institution was established, the overseers went through their districts, and asked, in all such mansions as could be supposed to harbour want, if the inhabitants stood in need of support? The question to all such poor as wished for relief, and were able to spin, was, Whether they did earn by their work 1s. 6d. a-week? for experience had taught the inhabitants of Hamburgh, that many poor live upon that sum; and they knew enough of their poor to suppose, that 1s. 6d. avowed earning was equal to something more. If the answer was affirmative, the pauper stood not in need of weekly assistance. If it was negative, work was given him, which, by being paid 30 per cent. above its value, afforded him 1s. 6d. a-week easily, if he was even an indifferent hand. The far more frequent cases were partial inability by age, or weakness, or want of skill. For poor of the latter description a school was opened, and in three months time the business was easily learnt. During that time, the pauper got first 2s. a-week, and every week afterward 2d. less, till in the twelfth week he got nothing at all but his earnings, and was dismissed, with a wheel and a pound of flax gratis.

The quantity of work which disabled poor were capable of doing in a week was easily and accurately ascertained by a week's trial in the spinning-school. The result was produced weekly before appointed members of the committee, and the sum which the poor could earn was noted down in their small books. The overseer was directed to pay them weekly what their earnings fell short of 1s. 6d. in every such week, when it appeared from their books that they had earned to the known extent of their abilities. From that moment applications became less frequent; and the committee had an infallible standard for distinguishing real want: for whenever the pauper, if in health (if not, he was peculiarly provided for), had not earned what he could, then he had either been lazy, or had found more lucrative work; in either case, he was not entitled to a relief for that week, whatever he might be for the following.

This mode of providing for the poor, which attracted the notice and obtained the eulogium of the minister and the British house of commons, has for six years been in Hamburgh attended with the happiest consequences. In the streets of that city a beggar is rarely to be seen, whilst those who stand in need of the charitable contributions of the rich, are much more comfortably, as well as at much less expence, maintained at home, with their children about them, than they could be in work-houses, under the management of mercenary overseers. For a fuller account of this judicious institution, we must refer our readers to Voght's Account of the Management of the Poor in Hamburgh, since the year 1788, in a Letter to some Friends of the Poor in Great Britain.

WORLD, the assemblage of parts which compose the globe of the earth. See GEOGRAPHY and ASTRONOMY.

WORM, in *Gunnery*, a screw of iron, to be fixed on the end of a rammer, to pull out the wad of a firelock, carabine, or pistol, being the same with the wad-hook, only the one is more proper for small arms, and the other for cannon.

WORM, in *Chemistry*, is a long winding pipe, placed in a tub of water, to cool and condense the vapours in the distillation of spirits.

Blind-Worm, or *Slow-Worm*. See ANGUIS, ERPETOLOGY *Index*.

Earth-Worm. See LUMBRICUS, HELMINTHOLOGY *Index*.

Glow-Worm. See LAMPYRUS, ENTOMOLOGY *Index*.

Silk Worm. See SILK, N° 5.

WORMS, VERMES. See HELMINTHOLOGY and CONCHOLOGY.

WORMS, in the human body. See MEDICINE, N° 407.

WORMS, in horses. } See FARRIERY.
WORMS, in dogs. }

WORMS for bait. See FISHING.

WORMS, an ancient and famous city of Germany, with a bishop's see, whose bishop was formerly a sovereign and prince of the empire. It is a free and imperial city, and the inhabitants are Protestants. It is famous for a diet held here in 1521, at which Luther assisted in person, in memory of which the Protestants built a handsome church, where Luther is represented as appearing at the diet. It is noted for the excellent wine that grows in the neighbourhood, which they call *our Lady's milk*. In the campaign of 1743, King Geo. II. took up his quarters in this city, and lodged at the bishop's palace after the battle of Dettingen. Worms fell into the hands of the French in 1794, and was included in the department of Mont Tonnere. It continued in their possession till 1814, when it was united to the territories of the duke of Hesse Darmstadt. It is seated on the western bank of the Rhine, 20 miles south-east of Mentz, and 32 south-west of Frankfort. E. Long. 8. 15. N. Lat. 49. 32.

WORMING OF DOGS. All dogs have certain strings under their tongues, by most called *a worm*; this must be taken out when they are about two months old, with the help of a sharp knife to slit it, and a shoemaker's awl to raise it up; you must be careful to take all out, or else your pains is to little purpose; for till then he will be hardly ever fat and right, in regard the worm or string will grow foul and troublesome, and hinder his rest and eating. This cruel operation is generally recommended as a preventive of madness in dogs, or at least as disabling them, if mad, from biting in that condition.

In this operation, of which the vulgar account is given,

ven above, which we have justly denominated a cruel one, it is not a string that is removed, but the duct by which the saliva is conveyed from the gland in which it is secreted to the mouth, for the purpose of mixing with the food and promoting its deglutition and digestion. Now this operation by no means prevents the animal from biting, nor can it, in our opinion, obstruct the flow of the saliva by which the dreadful disease hydrophobia is communicated.

WORMIUS, Olaus, a learned Danish physician, born in 1588 at Arhusen in Jutland. After beginning his studies at home, he studied at several foreign universities, and travelled to various parts of Europe for improvement. He returned to his native country in 1613, and was made professor of the belles lettres in the university of Copenhagen. In 1615, he was translated to the chair of the Greek professor; and in 1624 to the professorship of physic, which he held to his death. These occupations did not hinder him from practising in his profession, and from being the fashionable physician: the king and court of Denmark always employed him; and Christian IV. as a recompense for his services, conferred on him a canonry of Lunden. He published some pieces on subjects relating to his profession, several works in defence of Aristotle's philosophy, and several concerning the antiquities of Denmark and Norway; for which latter he is principally regarded, as they are very learned, and contain many curious particulars. He died in 1654.

WORMWOOD. See Artemisia, Botany *Index*.

WORSHIP of God (*cultus Dei*), amounts to the same with what we otherwise call *religion*. This worship consists in paying a due respect, veneration, and homage to the Deity, under a certain expectation of reward. And this internal respect, &c. is to be shown and testified by external acts; as prayers, sacrifices, thanksgivings, &c.

The Quietists, and some other mystic divines, set aside not only all use of external worship, but even the consideration of rewards and punishments. Yet even the heathens had a notion that God did not require us to serve him for nought: "Dii quamobrem colendi sint (says Cicero), non intelligo, nullo nec accepto ab illis nec sperato bono."

The school-divines divide worship into divers kinds, viz. *latria*, that rendered to God; and *idololatria*, that rendered to idols or images. To which the Romanists add, *dulia*, that rendered to saints; and *hyperdulia*, that to the Virgin. Some theological writers have observed, that the Greek word, προσκυνειν, *to worship*, is not descriptive only of the honour which is appropriated to God, but is indifferently used to signify the honour and respect which are paid to superiors of all kinds in heaven or on earth. Accordingly, they have distinguished between civil and religious worship.

That it is the duty of man to worship his Maker, has been sufficiently proved under other articles (see Prayer; and Theology, N° 40—45.). It is not indeed easily to be conceived how any one who has tolerably just notions of the attributes and providence of God, can possibly neglect the duty of *private* worship; and though we have admitted in the last of the two articles referred to, that *public* worship does not seem to be enjoined in that system which is called the religion of *nature*, yet it is most expressly commanded by the religion of Christ, and will be regularly performed by every one who reflects on its great utility.

As the illiterate vulgar cannot form to themselves correct notions of the divine providence and attributes, it is obvious, that without the institution of public worship, they would never think of worshipping God at all, unless perhaps occasionally, when under the pressure of some severe calamity; but occasional worship, the offspring of compulsion, could have little of the resigned spirit of true devotion. Ignorant, however, as the lowest of the vulgar are, and necessarily must be, it cannot be denied, that in most Christian countries, perhaps in all, they are more accurately acquainted with the first principles of religion, and the laws of morality, than even the leaders of barbarous nations. This superiority is doubtless owing in some measure to their access to the Sacred Scriptures, but much more, we are persuaded, to the instruction which they receive in the assemblies which they frequent for public worship. If this be admitted, public worship may be easily proved to be the duty of every individual of the community: For were those, who may be supposed to stand in no need either of the contagion of society to kindle their own devotion, or of the preaching of a clergyman to instruct them in the doctrines and precepts of the gospel, "to forsake, on these accounts, the assembling themselves together, as the manner of some is," religious assemblies and public worship would very quickly fall into universal disuse. Man is an animal prone to imitation; and every order in society is ambitious of treading in the footsteps of the order immediately above it. Were the wise and the good, therefore, permitted to absent themselves from the assemblies instituted for the public worship of the Creator and Redeemer of the world, others would quickly follow their example; impelled to it not only by this universal propensity, but by the additional motive of wishing to appear both to the world and to themselves as wise and as good as their privileged neighbours. The consequence is obvious: one man would stay from church with the serious intention perhaps of employing the Lord's day in private devotion and religious study; another, following his example, would absent himself upon the same pretence, but would in reality waste the day in dozing indolence or in secret sensuality. For these and other reasons which might be easily assigned, no sincere Christian will think himself at liberty to dispute a practice enjoined by the inspired preachers of his religion, coeval with the institution, and retained by every sect into which it has since been unhappily divided.

As Christian worship consists of prayers and praises, it has been a matter of some debate whether it is most properly performed by preconcerted forms or liturgies, or by extemporaneous addresses to the Almighty. Both these modes have their advantages and disadvantages; and by the sacred writers neither of them is prescribed in opposition to the other.

The advantages of a liturgy are, that it prevents absurd, extravagant, or impious addresses to God, which the folly or enthusiasm of individuals must always be in danger of producing; it gives the congregation an opportunity of *joining* in the prayers which are put up for them, which they cannot possibly do in a series of extemporaneous petitions, since before they can assent to any

any one of these and make it their own, their attention is necessarily called away to that which succeeds it; and it relieves the clergyman from the labour of composition, which seems incompatible with that fervour which constitutes the spirit of devotion.

The disadvantages of a fixed liturgy, which are the recommendations of extemporary prayer, are principally two. The forms composed in one age must, by the unavoidable change of language, circumstances, and opinions, become in some degree unfit for another; and the perpetual repetition of the same form of words is very apt to produce inattentive lassitude in the congregation. Would the clergy of the church of England take that liberty which is allowed them in the bidding prayer before sermon, perhaps the service of that church would unite in itself all the advantages both of liturgic and extemporary worship. We have only to add on this subject, that public prayers, whether precomposed or not, ought to be compendious; that they ought to express just conceptions of the Divine attributes; recite such wants as the congregation are likely to feel, and no other; that they ought to contain as few controverted propositions as possible; and that, if it can be done without offence, the pompous style of *the state* should be laid aside in our prayers for the king, and all that are in authority; because in every act which carries the mind to God, human greatness must be annihilated.

WORT, the infusion of malt, of which beer is made. See BREWING. The uses of this infusion in common affairs are well known. By Dr M'Bride it has lately been found to have a strong antiseptic virtue, and to be useful in preventing the scurvy and other diseases to which sailors are liable; this was confirmed by Captain Cook in his voyages. See *Means of Preserving the Health of SEAMEN*.

It is of great importance to the manufacturer to be able to ascertain with facility and precision the real strength of worts, or the quantity of saccharine matter contained in the infusion. This is accomplished by determining the specific gravity by means of instruments, which, from the purpose to which they are applied, have obtained the name of *saccharometers*. But as these instruments, from the very nature of the material of which they are constructed, are liable to considerable change, the results which they afford cannot always be depended on. With the view of obviating these inconveniences, the patent areometrical beads have been invented by Mrs Lovi of Edinburgh. We have already noticed these beads on account of their accuracy, simplicity, and facility of application for ascertaining the specific gravity, or the real strength and value of spirituous liquors. See vol. xix. p. 599.; and we now recommend them with greater confidence, from having had opportunities of knowing that they are capable of a more extended application, as in the manufacture of acids, and salts of different kinds; to ascertain the strength of acids, or that of saline solutions in bleaching; to determine the strength of liquids employed in the different processes of calico printing and dyeing, and not only for the purpose of examining the strength of the acids employed, but also particularly to ascertain the density or specific gravity of the colouring matters which are used in these arts, so that the same degree of shade required may be always obtained. It has been suggested, that these beads might be conveniently employed in determining the strength of mineral waters, which, it is well known, vary considerably at different seasons of the year.

As the patent beads are constructed on the same principle from 800, the specific gravity of alcohol, to 2000, which is double the specific gravity of water; and as they are divided into different series, each of which includes a range of specific gravities applicable to the particular fluids, the density or strength of which is required, we have no hesitation in asserting that they will be found extremely convenient and useful to all manufacturers and dealers, who wish to ascertain with accuracy the real strength and value of liquids.

It has been objected to the use of these beads, that they require a longer time than other instruments in using them. The same objection has been made to the introduction of other new instruments, the application of which frequent use has afterwards rendered familiar and easy. We have had opportunities of knowing that this objection is completely obviated by those who have been accustomed to use the beads. They find that they can determine the specific gravity of a liquid by means of the beads with the same facility, and in as short a time, as with any other instrument.

WOTTON, SIR HENRY, an eminent writer, was the son of Thomas Wotton, Esq. and was born in 1568. He studied for some time at New-college, Oxford, whence he removed to Queen's-college, where he made a great progress in logic and philosophy; wrote a tragedy for the use of that college, called *Tancredo;* and afterwards received the degree of master of arts. After this, leaving the university, he travelled into France, Germany, and Italy; and having spent about nine years abroad, he returned to England, and became secretary to Robert earl of Essex, with whom he continued till that earl was apprehended for high treason. He then retired to Florence, where he became known to the grand duke of Tuscany, who sent him privately with letters to James VI. king of Scotland, under the name of *Octavio Baldi*, to inform that king of a design against his life. Some months after he went back to Florence; but King James coming to the possession of the crown of England, Mr Wotton returned home, was knighted by his majesty, and sent ambassador to the republic of Venice; and afterwards was employed in many other embassies to that and other courts; but the only reward he obtained for these services was his having the provostship of Eton conferred upon him about the year 1623, which he kept till his death, which happened in 1639. After his decease some of his manuscripts and printed tracts were published together in a volume, intitled *Reliquiæ Wottonianæ*.

WOTTON, *Dr William*, a learned divine and writer, was the son of Mr Henry Wotton, B. D. rector of Wrentham in Suffolk, where he was born in 1666. He was educated by his father, a gentleman well skilled in the learned languages; under whom he made such amazing proficiency, that at five years of age it is said he could render several chapters of the gospels out of Latin and Greek, and many psalms in Hebrew, into his mother tongue. When he was very young, he remembered the whole of almost every discourse he had heard; and often surprised a preacher by repeating his sermon to him. He was admitted into Catharine-hall in Cambridge some months before he was ten years old; when the progress he made in learning in that university engaged

gaged Dr Duport, then master of Magdalen college, and dean of Peterborough, to write an elegant copy of Latin verses in his praise. In 1679 he took the degree of bachelor of arts when he was but twelve years and five months old; and the winter following he was invited to London by Dr Gilbert Burnet, then preacher at the Rolls, who introduced him to most of the learned men in that city, and particularly to Dr William Lloyd, bishop of St Asaph; to whom he recommended himself by repeating to him one of his sermons, as Dr Burnet had engaged he should. In 1691 he commenced bachelor of divinity. The same year Bishop Lloyd gave him the sinecure of Llandrillo, in Denbighshire. He was afterwards made chaplain to the earl of Nottingham, then secretary of state, who presented him to the rectory of Middleton Keynes, in Bucks, and to whom he dedicated his Reflections upon Ancient and Modern Learning. In 1705, Bishop Burnet gave him a prebend in the church of Salisbury; and in 1707, Archbishop Tenison presented him with the degree of doctor of divinity; but in 1714, the difficulties he laboured under with respect to his private fortune, obliged him to retire into South Wales, where he was treated with great kindness and humanity by the gentlemen of that country; and wrote there the "Memoirs of the Cathedral Churches of St David's and Landaff," and his "Miscellaneous Discourses relating to the Traditions and Usages of the Scribes and Pharisees;" which were afterwards printed. He died in 1726. This great man was remarkable for his humanity and friendliness of temper; the narrowness of a party spirit never broke in upon any of his friendships; and his time and abilities were at the service of any person who was making advances in real learning. He wrote, besides the above works, 1. A History of Rome. 2. A Defence of his Reflections upon Ancient and Modern Learning. 3. A Discourse concerning the Languages of Babel. 4. Advice to a young Student, with a Method of Study for the first four Years; and other learned pieces.

WOUNDS, in *Surgery*, have been divided into *simple*, *contused* or *lacerated*, and *gun-shot*.

Of Simple Wounds.—The first thing to be considered in the inspection of a wound is, whether it be likely to prove mortal or not. This knowledge can only be had from anatomy, by which the surgeon will be able to determine what parts are injured; and, from the offices which these parts are calculated to perform, whether the human frame can subsist under such injuries. It is not, however, easy for the most expert anatomist always to prognosticate the event with certainty; but this rule he ought always to lay down to himself, to draw the most favourable prognosis the case will bear, or even more than the rules of his art will allow. This is particularly incumbent on him in sea-engagements, where the sentence of death is executed as soon as pronounced, and the miserable patient is thrown alive into the sea, upon the surgeon's declaring his wound to be mortal. There are, besides, many instances on record, where wounds have healed, which the most skilful surgeons have deemed mortal. The following wounds may be reckoned mortal.

1 Wounds which are necessarily mortal.

1. Those which penetrate the cavities of the heart, and all those wounds of the viscera where the large blood-vessels are opened; because their situation will not admit of proper applications to restrain the flux of blood.

2. Those which entirely cut off the passage of the nervous influence through the body. Such are wounds of the brain, cerebellum, medulla oblongata, and spinal marrow. Wounds likewise of the small blood-vessels within the brain are attended with great danger, from the effused fluids pressing upon the brain. Nor is there less danger where the nerves which tend to the heart are wounded, or entirely divided; for, after this, it is impossible for the heart to continue its motion.

3. All wounds which entirely deprive the animal of the faculty of breathing.

4. Those wounds which interrupt the course of the chyle to the heart; such are wounds of the receptacle of the chyle, thoracic duct, and larger lacteals, &c.

5. There are other wounds which prove fatal if neglected and left to nature: such are wounds of the larger external blood-vessels, which might be remedied by ligature. Wounds of such parts generally prove fatal; and though a few instances may have occurred where people have recovered after them, yet they are always to be considered as extremely dangerous. Portions of the brain have been destroyed, and wounds have been made into it, and the patients have lived. It is possible, too, that the thoracic duct might be wounded and the patient live; Mr A. Cooper having shown, in a very ingenious paper in the Medical Records and Researches, that it may become obstructed, and the chyle conveyed into the system by anastomosing lymphatics.

In examining wounds, the next consideration is, whether the parts injured are such as may be supposed to induce dangerous symptoms, either immediately or at some period during the course of the cure. In order to proceed with any degree of certainty, it is necessary to be well acquainted with those symptoms which attend injuries of the different parts of the body. If the skin and part of the cellular substance are only divided, the first effects are an effusion of blood; the lips of the wound retract, become tumefied, red and inflamed, leaving a gap of considerable wideness according to the length and deepness of the wound. If a very considerable portion of skin and cellular substance is divided, a slight fever seizes the patient; the effusion of blood in the mean time stops, and the wound is partly filled up with a cake of coagulated blood. Below this cake, the small vessels pour forth a clear liquor, which in a short time is converted into pus (see the articles Pus and Mucus). Below this pus granulations of new flesh arise, the cake of coagulated blood loosens, a new skin covers the place where the wound was, and the whole is healed up; and there only remains a mark, called a *cicatrix* or *scar*, showing where the injury had been received.

All wounds are accompanied with a considerable degree of pain, especially when the inflammation comes on, though the division reaches no farther than the skin and cellular substance. If the muscular fibres are divided, the pain is much greater, because the sound part of the muscle is stretched by the contraction of the divided part and the action of the antagonist muscle, which it is now less fitted to bear. The wound also gapes much more than where the cellular substance is alone

alone divided, insomuch that, if left to itself, the skin will cover the muscular fibres, without any intervention of cellular substance; and not only a very unsightly cicatrix remains, but the use of the muscle is in some measure lost.—If the muscle happens to be totally divided, its fibres retract to a very considerable distance; and unless proper methods be taken to bring them into contact, the use of it is ever afterwards lost.

5 Of the arteries.

If by a wound any considerable artery happens to be divided, the blood flows out with great velocity, and by starts; the patient soon becomes faint with loss of blood; nor does the hæmorrhagy stop until he faints away altogether; and if as much *vis vitæ* still remains as is sufficient to renew the operations of life, he recovers after some time, and the wound heals up as usual. The part of the artery which is below the wound in the mean time becomes useless, so that all the inferior part of the limb would be deprived of blood, were it not that the small branches sent off from the artery above the wounded place become enlarged, and capable of carrying on the circulation. Nature also, after a wonderful manner, often produces new vessels from the superior extremity of the divided artery, by which the circulation is carried on as formerly. The consequences of such a profuse hæmorrhagy may be, however, very dangerous to the patient, by inducing extreme debility, or an universal dropsy. This great hæmorrhagy happens especially where the artery is partially divided; because then the vessel cannot contract in such a manner as to close the orifice: however, if the wound is but small, the blood gets into the cellular substance, swelling up the member to an extreme degree, forming what is called a *diffused aneurism*. Thus the hæmorrhagy soon stops externally, but great mischief is apt to flow from the confinement of the extravasated blood, from bringing on exterior suppuration among the muscles and bones; and thus not only the use of the limb is entirely lost, but the patient is brought into great danger of his life.

6 Of the ligaments, nerves, and tendons.

Wounds of the ligaments, nerves, and tendons, are likewise attended with bad consequences. When a nerve is entirely divided, the pain is but trifling, though the consequences are often dangerous. If the nerve is large, all the parts to which it is distributed below the wound immediately lose the power of motion and sensation. This, however, takes place only when all or the greatest part of the nerves belonging to a particular part are divided. If the spinal marrow, for instance, be divided near the head, the parts below soon lose their sensation irrecoverably; or if the bundle of nerves passing out of the axilla be divided, or tied, sensation in the greatest part of the arm below will be lost. But though a nerve should be divided, and a temporary palsy be produced, it may reunite, and perform its former functions. If a nerve be wounded only, instead of being divided, the worst symptoms frequently ensue.

7 Of the thorax, and the viscera which it contains.

Wounds which penetrate the cavities of the thorax are always exceedingly dangerous, because there is scarce a possibility of all the viscera escaping unhurt. A wound is known to have penetrated the cavity of the thorax principally by the discharge of air from it at each inspiration, by an extreme difficulty of breathing, and by coughing up blood. Such wounds, however, are not always mortal: the lungs have frequently been wounded, and yet the patient has recovered.—Wounds of the diaphragm are almost always mortal, either by inducing fatal convulsions immediately, or by the ascent of the stomach, which the pressure of the abdominal muscles forces up through the wound into the cavity of the thorax; of this Van Swieten gives several instances.—Even though the wound do not penetrate into the cavity of the thorax, the very worst symptoms may follow. For if the wound descends deeply among the external muscles, and its orifice lies higher, the extravasated blood will be therein collected, stagnate, and form various sinuses; which after having eroded the pleura, may at length pass into the cavity of the thorax. The matter having once found a vent into this cavity, will be continually augmenting from the discharge of the sinuous ulcer, and the lungs will at last suffer by the surrounding matter. If, in cases of wounds in the thorax, the ribs or sternum happen to become carious, the cure will be extremely tedious and difficult. Galen relates the case of a lad who received a blow upon his sternum in the field of exercise: it was first neglected, and afterwards badly healed; but, four months afterwards, matter appeared at the place which had received the blow. A physician made an incision into the part, and it was soon after cicatrized: but in a short time a new collection made its appearance, and upon a second incision the wound refused to heal. Galen found the sternum carious; and having cut off the diseased part, the pericardium itself was observed to be corroded, so that the heart could be seen quite naked; notwithstanding which, the wound was cured in no very long time.

There is sometimes difficulty in determining whether the wound has really penetrated into the thorax or into the abdomen; for the former descends much farther towards the sides than at the middle. But as the lungs are almost always wounded when the cavity of the thorax is penetrated, the symptoms arising from thence can scarcely be mistaken.—Another symptom which frequently, though not always, attends wounds of the thorax, is an emphysema. This is occasioned by the air escaping from the wounded lungs, and insinuating itself into the cellular substance; which being pervious to it over the whole body, the tumor passes from one part to another, till at last every part is inflated to a surprising degree. An instance is given in the Memoirs of the Royal Academy, of a tumour of this kind, which on the thorax was eleven inches thick, on the abdomen nine, on the neck six, and on the rest of the body four; the eyes were in a great measure thrust out of their orbits by the inflation of the cellular substance; and the patient died the fifth day. This was occasioned by a stab with a sword.

8 Of the abdomen and its viscera.

Wounds of the abdomen are not less dangerous than those of the thorax, on account of the importance of the viscera which it contains. When the wound does not penetrate the cavity, there is some danger of a hernia being formed by the protrusion of the peritonæum through the weakened integuments, and the danger is greater the larger the wound is. Those wounds which run obliquely betwixt the interstices of the muscles often produce sinuous ulcers of a bad kind. For as there is a large quantity of fat interposed everywhere betwixt the muscles of the abdomen, if a wound happens to run between them, the matter there collected, not meeting with free egress through the mouth of the wound, often makes its way in a surprising manner through the cellu-

lar

Wounds. lar substance, and forms deep sinuosities between the muscles; in which case the cure is always difficult, and sometimes impossible.

If a large wound penetrate the cavity of the abdomen, some of the viscera will certainly be protruded through it; or if the wound is but small, and closed up with fat so that none of the intestines can be protruded, we may know that the cavity of the abdomen is pierced, and probably some of the viscera wounded, by the acute pain and fever, paleness, anxiety, faintings, hiccough, cold sweats, and weakened pulse, all of which accompany injuries of the internal parts. The mischiefs which attend wounds of this kind proceed not only from the injury done to the viscera themselves, but from the extravasation of blood and the discharge of the contents of the intestines into the cavity of the abdomen; which, being of a very putrescent nature, soon bring on the most violent disorders. Hence wounds of the abdominal viscera are very often mortal. This, however, is not always the case, for the small intestines have been totally divided, and yet the patient has recovered. Wounds both of the small and large intestines have healed spontaneously, even when they were of such magnitude that the contents of the intestine were freely discharged through the wound into the abdomen, and after part of the intestines itself has been protruded through the wound of the integuments.

When the mesentery is injured, the danger is extreme, on account of its numerous vessels and nerves. Wounds of the liver, spleen, and pancreas, are also exceedingly dangerous, although there are some instances of the spleen being cut out of living animals without any considerable injury.

From the preceding account of the symptoms attending wounds in the different parts of the body, the surgeon may be enabled to judge in some measure of the event; though it must always be remembered, that wounds, even those which seemed at first to be of the slightest nature, have, contrary to all expectation, proved mortal, chiefly by inducing convulsions, or a locked jaw; so that no certain prognostic can be drawn on sight of recent wounds. We shall now, however, proceed to consider their treatment.

9
Treatment of wounds.

For the cure of wounds, it has been already observed, that the ancients imagined balsams, the juice of herbs, &c. to be specifics. In after-ages, and in countries where balsams are not easily to be procured, salves were substituted in their place; and even at this day there are many who reckon a salve or ointment essentially necessary for healing the slightest cut. It is certain, however, that the cure of wounds cannot be effected, nay, not even forwarded in the least, by ointments, unless in particular cases. That power which the human frame has of repairing the injuries done to itself, which by physicians is called *vis medicatrix naturæ*, is the sole agent in curing external injuries; and without this the most celebrated balsams would prove ineffectual. When a wound has been made with a sharp instrument, and is not extensive, if it be immediately cleaned and all the extravasated blood sucked (A) out or washed away, it will almost always heal by *adhesion*. When a wound does not heal by this process, there are three stages to be observed in its cure; the first, called suppuration, which takes place when the ends of the wounded vessels contract themselves, and pour out the liquor which is converted into pus. As soon as this appears, the second, or granulating stage, in which the flesh begins to grow up, takes place; and as this proceeds, the edges of the wound acquire a fine bluish or pearl colour, which is that of the new skin beginning to cover the wound as far as the granulations have filled it up. This process continues, and the skin advances from all sides towards the centre, which is called the *cicatrizing* of the wound. For the promoting of each of these processes, several ointments were formerly much in vogue. But it is now found, that no ointment whatever is capable of promoting them; and that it is only necessary to keep the wound clean, and to prevent the air from having access to it. This, indeed, nature takes care to do, by covering the wound with a cake of coagulated blood; but if a wound of any considerable magnitude should be left entirely to nature, the pus would form below the crust of coagulated blood in such quantity, that it would most probably corrupt, and the wound degenerate into a corroding ulcer. It is necessary, therefore, to cleanse the wound frequently; for this purpose it will be proper to apply a little ointment spread on soft scraped lint. And, in a healthy body, the wound will heal without farther trouble. As to the ointment employed, it is almost indifferent what it be, provided it has no acrid or stimulating ingredient in its composition; hogs lard or the simple ointment of the Pharmacopeia will answer perfectly.

But though, in general, wounds thus easily admit of a cure, there are several circumstances which require a different treatment, even in simple divisions of the fleshy parts, when neither the membranous nor tendinous parts are injured. These are, 1. Where the wound is large, and gapes very much, so that, if allowed to heal in the natural way, the patient might be greatly disfigured by the scar. It is proper to bring the lips of the wound near to each other, and to join them either by adhesive plaster or by suture, according as the wound is superficial, or deep. 2. When foreign bodies are lodged in the wound, as when a cut is given by glass, &c. it is necessary to extract them, before the wound is dressed: for it will never heal until they are discharged. When these bodies are situated in such a manner as not to be capable of being extracted without lacerating the adjacent parts, which would occasion violent pain and other bad symptoms, it is necessary to enlarge the wound, so that these offending bodies may be easily removed. This treatment, however, is chiefly necessary in gunshot wounds, of which we shall afterwards speak. 3. When the wound is made in such a manner that it runs for some length below the skin, and the bottom is much lower than the orifice, the matter collected from all parts of the wound will be lodged in the bottom of it, where, corrupting by the heat, it will degenerate into a fistulous ulcer. To prevent this, we must

(A) See an account of the method of sucking wounds, in Mr John Bell's *Discourses on Wounds*, Part I. discourse v. p. 215.

Wounds. must use compresses, applied so that the bottom of the wound may suffer a more considerable pressure than the upper part of it. Thus the matter formed at the bottom will be gradually forced upwards, and that formed at the upper part will be incapable of descending by its weight; the divided parts, in the mean time, easily uniting when brought close together. Indeed, the power which nature has of uniting different parts of the human body is very surprising; for, according to authors of credit, even if a piece of flesh be totally cut out, and applied in a short time afterwards to the place from whence it was cut, it will unite. That a part cut out of a living body does not entirely lose its vital power for some time, is evident from the modern practice of transplanting teeth; and from an experiment of Mr John Hunter's, where he put the testicle of a cock into the belly of a living hen, and the testicle adhered to the liver, and became connected to it by means of blood vessels*. We have therefore the greatest reason to hope, that the divided parts of the human body, when closely applied to each other, will cohere without leaving any sinus or cavity between them. However, if this method should fail, and matter be collected in the depending part of the wound, it will be necessary to make an opening in that part in order to let it out; after which the wound may be cured in the common way. 4. During the course of the cure, it sometimes happens that the wound, instead of filling up with granulations of a florid colour, shoots up into a glassy-like substance which rises above the level of the surrounding skin, while, at the same time, instead of laudable pus, a thin ill-coloured and fetid ichor is discharged. In this case the lips of the wound lose their beautiful pearl colour, and became callous and white, nor does the cicatrizing of the wound at all advance. When this happens in a healthy patient, it generally proceeds from some improper management, especially the making use of too many emollient and relaxing medicines, an immoderate use of balsams and ointments. Frequently nothing more is requisite for taking down this fungus than dressing with dry lint: at other times desiccative powders, such as calamine, tutty, calcined alum, &c. will be necessary; and sometimes red precipitate mercury must be used. This last, however, is apt to give great pain, if sprinkled in its dry state upon the wound; it is therefore most proper to grind it with some yellow basilicon ointment, which makes a much more gentle, though at the same time an efficacious escharotic. Touching the overgrown parts with blue vitriol is also found very effectual.

* See ...ood, ... 19.

10 Of the regimen of patients in wounds.

Hitherto we have considered the wounded patient as otherwise in a state of perfect health; but it must be observed, that a large wound is capable of disordering the system to a great degree. If the patient is strong and vigorous, and the pain and inflammation of the wound great, considerable degree of fever may arise, which it will be necessary to check by bleeding, low diet, and other parts of the antiphlogistic regimen, at the same time the inflamed lips of the wound and parts adjacent are to be treated with emollient fomentations or cataplasms till the pain and swelling abate. On the other hand, it may happen, when the patient is of a weak and lax habit, that the *vis vitæ* may not be sufficient to excite such an inflammation in the wound as is absolutely necessary for its cure. In this case, the edges of the wound look pale and soft; the wound itself ichorous and bloody, without any signs or granulations; or if any granulations shoot up, they are of the fungous glassy kind above mentioned. To such wounds all external applications are vain; it is necessary to strengthen the patient by proper internal remedies, among which the bark has a principal place, until the wound begins to alter its appearance. In such persons, too, there is some danger of a hectic fever by the absorption of matter; and this will take place during the course of the cure, even when the appearances have been at first as favourable as could be wished. This happens generally when the wound is large, and a great quantity of matter formed; for by this discharge the patient is weakened; so that the pus is no sooner formed, than it is reconveyed into the body by the absorbent vessels, and immediately affects the patient with feverish heat. When this takes place, the best remedy is to exhibit the bark copiously, at the same time to support the patient by proper cordials and nourishing diet. Indeed, in general, it will be found, that, in the case of wounds of any considerable magnitude, a more full and nourishing regimen is required than the patient, even in health, has been accustomed to; for the discharge of pus alone, where the quantity is considerable, proves very debilitating. And it is constantly found, that the cure of such sores goes on much more easily when the patient is kept in his usual habit of body, than when his system is much emaciated by a very low allowance; and, for the same reason, purgatives, taken more freely than what is necessary to keep the bowels open, and whatever else tends to weaken the constitution, are improper in the cure of wounds.

11 Of hæmorrhagies from wounds.

Hæmorrhagies very frequently happen in wounds, either from a division of a large artery, or of a number of small ones. In this case, the first step to be taken by the surgeon is to effect a temporary stoppage of the blood by means of compression, and he is then to tie up all the larger vessels according to the methods usually directed.

When the principal arteries of a wound have been tied, and a little blood continues to be discharged, which appears to come from sundry small vessels only, an experienced surgeon is induced to think, that the compression of the bandages will in all probability effect a total stoppage of the hæmorrhagy. In a general oozing from the whole surface of a sore, and when no particular vessel can be distinguished, there is a necessity for trusting to the bandage or compression; but whenever an artery can be discovered, of whatever size it may be, it ought to be secured by a ligature. But it frequently happens, that considerable quantities of blood are discharged, not from any particular vessel, but from all the small arteries over the surface of the wound; and in wounds of great extent, particularly after the extirpation of cancerous breasts, and in other operations where extensive sores are left, this species of hæmorrhagy often proves very troublesome by being exceedingly difficult to suppress.

In constitutions perfectly healthy, on the occurrence of wounds even of the most extensive nature, as soon as the larger arteries are secured, all the small vessels which have been divided are diminished, not only in their diameters, but also in their length; in consequence of which, they recede considerably within the surface of the

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the surrounding parts. This cause of itself would probably, in the greatest number of instances, prove sufficient for restraining all loss of blood from the smaller arteries. Another very powerful agent however is provided by nature for producing the same effect. From the extremities of the divided vessels which at first discharged red blood, there now, in their contracted state, oozes out a more thin, though viscid fluid, containing a great proportion of the coagulable parts of the blood; and this being equally distributed over the surface of the wound, by its agglutinating powers has a very considerable influence in restraining all such hæmorrhagies.

When a tedious oozing occurs in a patient young and vigorous, and where the tone of the muscular fibres is evidently great, the most effectual means of putting a stop to the discharge is to relax the vascular system, either by opening a vein in some other part, or, what gives still more immediate relief, by untying the ligature on one of the principal arteries of the part, so as to allow it to bleed freely: those violent spasmodic twitchings too, so frequent after operations in any of the extremities, when they do not depend on a nerve being included in the ligature with the artery, are in this manner more effectually relieved than by any other means.

By the same means the patient, from being in a febrile heat and much confused, soon becomes very tranquil: the violent pulsation of the heart and larger arteries abates, and the blood not being propelled with such impetuosity into the smaller vessels of the part, they are left at more liberty to retract.

The patient ought to be kept exceedingly cool; wine and other cordials should be rigidly avoided; cold water, acidulated either with the mineral or vegetable acids, ought to be the only drink; motion of every kind, particularly of the part affected, should be guarded against; and the lip of the wound being drawn together by adhesive plaster, and gently covered with soft charpie, it ought to be tied up with a bandage so applied as to produce a moderate degree of pressure on the extremities of the divided parts.

As soon as a sufficient quantity of blood has been discharged, the wound dressed, and the patient laid to rest, a dose of opium proportioned to the violence of the symptoms ought to be immediately exhibited. It ought to be remarked, however, that in all such circumstances, much larger doses of this medicine are necessary than in ordinary cases requiring the use of opiates. Small doses, instead of answering any good purpose, seem frequently rather to aggravate the various symptoms; so that whenever they are had recourse to in such cases, they ought always to be given in quantities sufficient for the intended effect.

But hæmorrhagies of this nature happen much more frequently in relaxed enfeebled habits, where the solids have lost part of their natural firmness, and the fluids have acquired a morbid tenuity. In this case a moderate use of generous wine ought to be immediately prescribed; for nothing tends so much, in such circumstances, to restrain hæmorrhagies, as a well directed use of proper cordials. By tending to invigorate and brace the solids, they enable the arterial system to give a due resistance to the contained fluids; and have also a considerable influence in restoring to the fluids that viscidity of texture, of which in all such instances we suppose them to be deprived.

A nourishing diet also becomes proper; the patient ought to be kept cool; and the mineral acids, from their known utility in every species of hæmorrhagy, ought also to be prescribed. Rest of body is here also proper; and opiates, when indicated either by pain or spasmodic affections of the muscles, ought never to be omitted.

Together with these remedies adapted to the general system, particular dressings, appropriated to the state of the parts to which they are to be applied, have been found very beneficial. In healthy constitutions, soon after the discharge of blood is over, the parts are covered with a viscid coagulable effusion from the mouths of the now retracted arteries; but in constitutions of an opposite nature, where the solids are much relaxed, the blood in general is found in such an attenuated state as to afford no secretion of this nature.

To supply as much as possible the deficiency of this natural balsam, different artificial applications have been invented. Dusting the part with starch or wheat-flour has sometimes been found of use, and gum arabic in fine powder has been known to answer when these failed.

Applications of this kind, indeed, have been used with success in all such hæmorrhagies, with whatever habit of body they happen to be connected; but they have always proved more particularly serviceable in relaxed constitutions, attended with an attenuated state of the blood and an enfeebled muscular system. Alcohol, or any other ardent spirits, impregnated with as great a quantity as they can dissolve of myrrh, or any other of the heating viscid gums, may be here used with freedom, though in constitutions of an opposite nature they ought never to be employed. The *balsamum traumaticum* of the shops, a remedy of this nature, has long been famous for its influence in such cases: but that indiscriminate use of this and similar applications which has long prevailed with some practitioners, has undoubtedly done much harm; for as they are all possessed of very stimulating powers, they of course tend to aggravate every symptom in wounds connected with a tense state of fibres, or much pain, especially when spasmodic muscular affections prevail.

By a due perseverance in one or other of the plans here pointed out, it will seldom happen that hæmorrhagies are not at last put a stop to: but when the contrary does occur, when, notwithstanding the use of the remedies recommended, a discharge of blood still continues; in addition to the means already advised, an equal moderate pressure ought to be applied over the whole surface of the sore, to be continued as long as the necessity of the case seems to indicate.

In finishing the dressings of such wounds, after the adhesive plaster and compresses have been applied, a bandage properly adapted to the part ought to be employed, and in such a manner as to produce as equal a degree of pressure over the surface of the wound as possible. But it now and then happens that no bandage can be applied so as to produce the desired effect; and in such cases the hand of an assistant is the only resource; which being firmly pressed over the dressings, will commonly succeed when no other means is found to have much influence.

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Wounds of the nerves, tendons, and ligaments, are attended with much more violent symptoms than those where even considerable arteries are divided, and they frequently resist every method of cure proposed by the most skilful practitioners. In the simple process of blood-letting, it frequently happens that the tendinous expansion called the *aponeurosis* of the biceps muscle is wounded, or even the tendon of that muscle itself is punctured, by the point of the lancet; or sometimes a nerve which happens to lie in the neighbourhood is partially divided. Any one of these wounds, though they are the smallest we can well suppose to be given, are frequently very dangerous and difficult of cure. It sometimes immediately happens on the introduction of the lancet, that the patient complains of a most exquisite degree of pain; and when this occurs, we may rest assured that either a tendon or a nerve has been wounded. On some occasions, by proper management, such as evacuating a considerable quantity of blood at the orifice newly made, by keeping the part at perfect rest, and preserving the patient in as cool a state as possible, the pain at first complained of will gradually abate, and at last go off entirely without any bad consequence. At other times, however, this pain which occurs instantaneously on the introduction of the lancet, instead of abating, begins soon to increase; a fullness, or small degree of swelling, takes place in the parts contiguous to the wound; the lips of the sore become somewhat hard and inflamed; and, in the course of about 24 hours from the operation, a thin watery serum begins to be discharged at the orifice.

If, by the means employed, relief is not soon obtained, these symptoms generally continue in nearly the same state for two or perhaps three days longer. At this time the violent pain which at first took place becomes still more distressing; but instead of being sharp and acute as before, it is now attended with the sensation of a burning heat, which goes on to increase, and proves, during the whole course of the ailment, a source of constant distress to the patient. The fullness and hardness in the lips of the wound begin to increase, and the swelling in the neighbouring parts gradually extends over the whole members. The parts at last become exceedingly tense and hard; an erysipelatous inflammatory colour frequently appears over the whole member; the pulse by this time is generally very hard and quick; the pain is now intense, the patient exceedingly restless; twitchings of the tendons occur to a greater or less degree; on some occasions, a locked jaw and other convulsive affections supervene; and all these symptoms continuing to increase, it most frequently happens that the torture under which the patient has been groaning is at last terminated by death.

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Different opinions have prevailed respecting the cause of these symptoms. By some they have been imputed to wounds of the tendons. By others the tendons are supposed to be so entirely destitute of sensibility, as to be quite incapable of producing so much distress; so that wounds of the nerves they consider, on all such occasions, as the true cause of the various symptoms we have mentioned.

One or other of these ideas continued to be the only source for explaining the various phenomena found to occur in this malady, till a different opinion was suggested by the late ingenious Mr John Hunter of London. Mr Hunter supposed, that all the dreadful symptoms found now and then to be induced by the operation of blood-letting, might be more readily accounted for from an inflamed state of the internal surface of the vein, than from any other cause. Such a state of the vein he has often traced in horses that have died of such symptoms from venesection, and the same appearances have sometimes occurred also in the human body. And on other occasions, inflammation having in this manner been once excited, has been known to terminate in suppuration; and the matter thus produced being in the course of circulation carried to the heart, Mr Hunter supposes that in such cases death may have been induced by that cause alone.

Wounds.
14
Mr John
Hunter's
opinion

There can be no reason to doubt the fact held forth by Mr Hunter, that in such instances the vein in which the orifice has been made, has frequently after death been found greatly inflamed: but however ingenious his arguments may be for concluding that the state of the vein is the original cause of all the bad symptoms enumerated, and although we must allow that such an inflammatory affection of a vein must have a considerable influence in aggravating the various symptoms previously induced by other causes; yet we may very fairly conclude, that it could not probably in any one instance be able to account with satisfaction for their first production.

In many cases the patient, at the very instant of the operation, feels a very unusual degree of pain. In some cases, the violence of the pain is almost unsupportable. Now this we can never suppose to have been produced by the mere puncture of a vein; for although the coats of veins are not perhaps entirely destitute of feeling, yet we know well that they are not endowed with such a degree of sensibility as to render it probable that such intense pain could ever be induced by their 15
being punctured in any way whatever. This inflamed not just.
state of the veins therefore, as detected by Mr Hunter after death, must be considered rather as being produced by, than as being productive of, such affections; and that such ailments should frequently produce an inflammation of the contiguous veins, is a very probable conjecture. In the course of 48 hours from the operation, when the febrile symptoms are just commencing, such a degree of hardness and evident inflammation is induced over all the parts contiguous to the orifice, that it would be surprising indeed if the vein, which is thus perhaps entirely surrounded with parts highly inflamed, 16
should escape altogether. We shall therefore proceed Really ow-
upon the supposition of this inflamed state of the veins ing to the
being a consequence rather than the cause of such ail- partial
ments; and of course we now revert to one or other of wounding of a nerve
the opinions long ago adopted on this subject, that all or tendon.
the train of bad symptoms found on some occasions to succeed venesection, proceeds either from the wound of a nerve or of a tendon.

That a partial wound of a nerve will now and then produce very distressing symptoms, no practitioner will deny: but it has been attempted to be shown, that tendons are almost totally destitute of sensibility; and it has therefore been supposed, that their being wounded can never account for the various symptoms known to occur in such cases. There is great reason however to think, that in different instances the same train of symptoms have been induced by different causes; that in one instance

Wounds. instance a wounded nerve, and in others pricks of the tendons, have given rise to them, as we have already supposed.

17 Method of obviating these symptoms, and curing the wound.

In order to prevent as much as possible the consequent inflammation and other symptoms which usually ensue, a considerable quantity of blood should be immediately discharged at the orifice just made: the limb, for several days at least, ought to be kept in a state of perfect rest, care being at the same time taken to keep the muscles of the part in as relaxed a state as possible: the patient should be also kept cool, on a low diet; and, if necessary, gentle laxatives ought to be administered.

When, notwithstanding these means, the symptoms, instead of diminishing, rather become more violent; if the lips of the orifice turn hard and more inflamed, if the pain become more considerable, and especially if the swelling begin to spread, other remedies come to be indicated. In this state of the complaint, topical bloodletting, by means of leeches applied as near as possible to the lips of the wound, frequently affords much relief; and when the pulse is full and quick, it even becomes necessary to evacuate large quantities of blood by opening a vein in some other part.

The external applications usually employed in this state of the complaint are warm emollient fomentations and poultices. In similar affections of other parts no remedies with which we are acquainted would probably be found more successful; but in the complaint now under consideration, all such applications, instead of being productive of any advantage, rather do harm. The heat of the part is here one of the most distressing symptoms; and warm emollient applications rather tend to augment this source of uneasiness. The lips of the wound also are rendered still more hard, swelled, and of course more painful; and the swelling of the contiguous parts is increased. The best external remedies are cooling astringents, especially the saturnine applications. The parts chiefly affected being alternately covered over with cloths wet with a solution of saccharum saturni, and pledgets spread with Goulard's cerate, are kept more cool and easy than by any other remedy hitherto used. The febrile symptoms which occur must at the same time be attended to, by keeping the patient cool, on a low diet, preserving a lax state of the bowels; and, if necessary, farther quantities of blood ought to be evacuated.

On account of the violence of the pain, which is sometimes so excessive as to destroy entirely the patient's rest, opiates ought to be freely exhibited; and when twitchings of the tendons and other convulsive symptoms supervene, medicines of this kind become still more necessary. In order, however, to have a proper influence in this state of the complaint, opiates ought to be given in very full doses; otherwise, instead of answering any good purpose, they constantly tend to aggravate the different symptoms, not only by increasing the heat and restlessness, but by having an evident influence in rendering the system more susceptible than it was before of the pain and other distressing effects produced upon it by the wound.

It often happens, however, either from neglecting the wound or from improper treatment, that all these remedies are had recourse to without any advantage whatever: the fever, pain, and swelling of the parts continue, and convulsive affections of the muscles at last occur, all tending to indicate the most imminent danger. In this situation of matters, if we have not immediate recourse to some effectual means, the patient will soon fall a victim to the disorder; and the only remedy from which much real advantage is to be expected, is a free and extensive division of the parts in which the orifice producing all the mischief was at first made. We know well, from the experience of ages, that much more pain and distress of every kind are commonly produced by the partial division either of a nerve or of a tendon, than from any of these parts being at once cut entirely across. Now the intention of the operation here recommended, is to produce a complete division of the nerve or tendon we suppose to have been wounded by the point of the lance, and which we consider as the sole cause of all the subsequent distress.

This operation being attended with a good deal of pain, and being put in practice for the removal of symptoms from which it is perhaps difficult to persuade the patient that much danger can occur, all the remedies we have mentioned should be made trial of before it is proposed: but at the same time, care ought to be taken that the disorder is not allowed to proceed too far before we have recourse to it; for if the patient should be previously much weakened by the feverish symptoms having continued violent for any length of time, neither this remedy nor any other with which we are acquainted would probably have much influence. As soon, therefore, as the course already prescribed has been fairly tried, and is found to be inadequate to the effects expected from it, we ought immediately to have recourse to a free division of the parts affected.

Wherever a wounded or ruptured tendon may be situated, the limb should be placed in such a manner as will most readily admit of the retracted ends of the tendon being brought together; and when in this situation, the muscles of the whole limb in which the injury has happened must be tied down with a roller, so as to prevent them from all kinds of exertion during the cure, endeavouring at the same time to keep the parts easy and relaxed. Thus, in a wound or rupture of the tendon of the rectus muscle of the thigh, the patient's *leg* should be kept as much as possible stretched out during the cure, while the thigh should be in some degree bent, to relax the muscle itself as far as possible.

In similar affections of the tendo achillis, the *knee* should be kept constantly bent to relax the muscles of the leg, and the foot should be stretched out to admit of the ends of the ruptured tendon being brought into contact. A roller should be applied with a firmness quite sufficient for securing the muscles and tendons in this situation; but care must be taken to prevent it from impeding the circulation. With this view, soft fine flannel should be preferred either to linen or cotton; for being more elastic, it more readily yields to any swelling with which the limb may be attacked.

The late Dr Monro was the first who gave any accurate directions for the treatment of rupture in the large tendons; and it is perhaps given with more precision, from his having himself experienced the effects of this misfortune in the tendo achillis.

He used a foot-sock or slipper, made of double quilted ticking, and left open at the toe; from the heel of which a strap went up above the calf of the leg. A strong

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strong piece of the same materials went round the calf, and was fastened with a lace. On the back part of this was a buckle, through which the strap of the foot-sock was passed, by which the calf could be brought down, and the foot extended at pleasure. Besides there was a piece of tin applied to the fore part of the leg, to prevent the foot from getting into any improper posture during sleep. After proposing to walk, he put on a shoe with a heel two inches deep; and it was not till the expiration of five months that he ventured to lay aside the tin-plate; and he continued the use of the high-heeled shoe for two years.

From this treatment a knowledge may be formed of the treatment necessary to be followed in the laceration of tendons of other parts of the body.

19
Wounds of thorax.

In wounds of the thorax, even though none of the viscera should be wounded, we may yet reasonably expect that a considerable quantity of blood will be extravasated; and this, if very large, must be evacuated if possible. However, it ought to be particularly observed, that this extravasated blood should not be discharged before we are assured that the wounded vessels have done bleeding. When the pulse appears sufficiently strong and equal, the extremities warm, no hickup or convulsion, and the patient's strength continues, we may then know that the internal hæmorrhagy has ceased, and that the means for discharging the blood may now be safely used. Matter, water, and blood have sometimes vanished from the cavities of the thorax, and been afterwards discharged by sweat, urine, &c. Yet this but seldom happens; and if we were to trust to nature alone in these cases, it is certain that many would perish from a destruction of the vital viscera by the extravasated blood, who by an artificial extraction of the same blood might have been saved.

20
Wounds of the abdomen.

Wounds of the abdomen must be closed as soon as possible, and then treated as simple wounds; only they ought to be dressed as seldom and expeditiously as possible. Copious bleeding and a spare diet, with other parts of the antiphlogistic regimen, are here absolutely necessary.

It sometimes happens, that, through a large wound of the abdominal integuments, the intestine comes out without being injured. The most certain method, in all such cases, is to return the protruded part as soon as possible; for although writers in general formerly recommended warm fomentations, &c. to be previously applied, the latest authors upon this subject consider the most natural and proper fomentation to be that which is produced by the heat and moisture of the patient's belly, and that therefore the intestines, if no mortification has taken place, are to be cleared from extraneous matter, and immediately returned.

When the wound of the abdomen is large, the intestines easily prolapse, and they are as easily returned. But when part of an intestine has been forced through a narrow wound, it is much more dangerous. For the prolapsed intestine being distended by flatus, or the ingested aliments driven thither by the peristaltic motion, it will become inflamed, tumefied, and incapable of being returned through the stricture of the wound; whence gangrene will soon follow. In this case the utmost care is to be taken to reduce the intestine to its natural size. When this cannot be accomplished by other means, some practitioners of great eminence have even advised the puncturing of the intestine in different places in order to discharge the flatus. This practice has also been recommended in an incarcerated hernia, but is exceedingly disapproved of by Mr Pott and later writers; and it seems to be very dubious whether any good can possibly arise from it. To puncture any part that is already inflamed, must undoubtedly add to the inflammation; and it is very improbable that the discharge of flatus procured by the punctures would be at all a recompense for the bad consequences produced by the increased inflammation. The method of Celsus is much more eligible: It is to dilate the wound so as to reduce the intestine with ease.

Sometimes part of the intestine is lost either by suppuration or gangrene. In this case, all that can be done is to put a single stitch through the wounded bowel, and to fix it to the external wound by passing the suture also through the sides of the wound. The ends of the intestine may perhaps adhere; or at any rate the wound will continue to perform the office of an anus, out of which the fæces will continue to be discharged during life. The directions given by some surgeons about inserting the upper end of the gut into the lower, and stitching them together, are perfectly impracticable; and even if they were practicable, would certainly produce new mortification, which could not but be fatal.

When the omentum appears prolapsed, the same general treatment is to be observed; only that, when it is mortified, the dead part may be safely extirpated.—We shall conclude the article of abdominal wounds with a case from the memoirs of the academy of sciences for the year 1705, which shows that we ought not to despair, even though the most desperate symptoms should take place. A madman wounded himself in 18 different places of the abdomen. Eight of these penetrated the cavity, and injured the contained viscera; he had a diarrhœa, nausea, and vomiting, tension of the abdomen, with difficult respiration and violent fever, so that his life was despaired of. During the first four days he was blooded seven times; and during the greatest part of the cure his diet consisted almost entirely of flesh-broths, with the addition of some mild vegetables. By these means he was not only cured of his wounds, but restored to his right senses. Seventeen months after, he went mad again, and threw himself over a precipice, by which he was instantly killed. On opening the body, the wounds were found to have penetrated the middle lobe of the liver, the intestinum jejunum, and the colon.

Such extraordinary cures are to be imputed, according to the satisfactory explanation of Mr J. Bell, to the abdomen being perfectly full, and constantly subjected to strong pressure between the diaphragm and abdominal muscles; which keeps the parts contiguous to a wound closely applied to it, also in some measure prevents the discharge of fæces or even of blood, and gives an opportunity for a very speedy adhesion between the parts.

21
Wounds of the head.

In wounds of the head, where the cellular membrane only is affected, and the aponeurosis and pericranium are untouched, phlebotomy, lenient purges, and the use of the common febrifuge medicines, particularly those of the neutral kind, generally remove all the threatening symptoms. When the inflammation is gone off, it leaves on the skin a yellowish tint and a dry scurf, which continue until perspiration takes them away; and upon the

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removal of the disease, the wound immediately recovers a healthy aspect, and soon heals without further trouble. But in the worst kind of these wounds, that is, where a small wound passes through the tela cellulosa and aponeurosis to the pericranium, the patient will admit of more free evacuations by phlebotomy than in the former. In both, the use of warm fomentations is required; but an emollient cataplasm, which is generally forbid in the erysipelatous swellings, may in this latter case be used to great advantage. Where the symptoms are not very pressing, nor the habit very inflammable, this method will prove sufficient; but it sometimes happens that the scalp is so tense, the pain so great, and the symptomatic fever so high, that by waiting for the slow effect of such means the patient runs a risk from the continuance of the fever; or else the injured aponeurosis and pericranium become sloughy, produce an abscess, and render the case both tedious and troublesome. A division of the wounded part, by a simple incision down to the bone, about half an inch or an inch in length, will most commonly remove all the bad symptoms; and if it be done in time, will render every thing else unnecessary.

22
Wounds of the joints.

The wounds penetrating into the cavities of the joints do not seem at first alarming; yet, by exposure to the air, the lining membrane of such cavities acquires such a degree of sensibility as to endanger life when they are large. As soon therefore as any extraneous body, pushed into the joint, is removed, the admission of the external air is to be guarded against as much as possible. If the wound be not too large, this may be done by pulling the skin over the wound of the joint; and, to prevent its retraction, rather adhesive plaster, with proper bandaging, is to be used. But when inflammation has come on, repeated and copious blood-letting, together with fomentations, becomes necessary; and as the pain, in these cases, is apt to be violent, opiates must be administered; but should matter be formed in the cavity of the joint, free vent must be given to it.

Of contused and lacerated Wounds.—When the small vessels are ruptured by a blow with any hard instrument without penetrating the skin, at the same time that the solid fibres of the part are crushed, the injury is termed a *contusion:* and when at the same time the skin is broken, it is termed a *contused and lacerated wound.*

23
Symptoms and effects of contusions.

Every contusion therefore, whether the skin is broken or not, may be properly reckoned a wound; where the injury is so slight that none of the contents of the small vessels are extravasated, it scarcely deserves to be mentioned. The immediate consequence of a contusion, therefore, is a swelling, by reason of the extravasation just mentioned; and the skin becomes discoloured by the blood stagnating under it; but as this fluid, even though covered by the skin, cannot long remain in the natural state, it thence happens, that the contused part soon loses its florid red colour, and becomes blue or black; the thinner parts being in the mean time gradually taken up by the absorbent vessels. This at last happens to the blood itself; the blue disappears, and is succeeded by a yellowish colour, showing that the blood is now dissolved; after which, the part recovers its former appearance, and the ruptured vessels appear to have united as if no injury had happened.

These are the symptoms which attend the slightest kind of contusions; but it is evident, that where the blow is so violent as to rupture the blood-vessels or end some of the large nerves, all the bad consequences which attend simple wounds of those parts will ensue, and they will not be at all alleviated by the circumstance of the skin remaining whole. Hence it is easy to see how a contusion may produce ulcers of the worst kind, gangrene, sphacelus, carious bones, &c.; and if it happen to be on a glandular part, a schirrus or cancer is very frequently found to ensue. Even the viscera themselves, especially of the abdomen, may be injured by contusions to such a degree as to produce an inflammation, gangrene, or schirrus, nay instant death, without rupturing the skin.

Of Gun-shot Wounds.—Gun-shot wounds can be considered in no other light than contused wounds. In those made by a musket or pistol ball, the first things to be done are, to extract the ball, or any other extraneous body which may have lodged in the wounded part; and to stop the hemorrhagy, if there be an effusion of blood from the rupture of some considerable artery.

It is frequently necessary to enlarge the wound in order to extract the ball; and if it has gone quite through (provided the situation of the part wounded will admit of its being done with safety), the wound is to be laid freely open through its whole length; by which means any extraneous body will be more readily removed, and the cure facilitated.

In order to get at the ball, or any foreign matter, the probe is to be used as sparingly as possible: and this must appear evident to any one who will only consider the nature of the symptoms attendant on penetrating wounds of the breast or belly, either from a bullet or sharp instrument; the thrusting in a probe to parts under such circumstances being unavoidably a fresh stab on every repetition. Wherever probing is necessary, the finger is to be preferred as the best and truest probe, where it can be used.

If a ball, or any other foreign body, happen to be lodged near the orifice, or can be perceived by the finger to lie under the skin, though at some distance from the mouth of the wound, we should cut upon it and take it out: but when it is sunk deep, and lies absolutely beyond the reach of the finger, it must appear evident on the least reflection, that thrusting, first a long probe in quest of the bullet, and then, as has been likewise practised, a long pair of forceps, either with or without teeth, into a wound of that kind, though with some certainty to extract it, must either contuse, or irritate and inflame the parts to a great degree; and consequently do as much, or more, mischief as the ball did at first in forcing its passage to such a length. And should they at the same time lay hold of any considerable artery or nerve along with the ball (which can scarce ever fail of being the case), what shocking consequences would attend such a proceeding! Nor would attempts of this sort be less injurious, if a bullet should happen to be lodged in the cavity of the belly or breast. Such attempts are the less necessary, because a great number of instances have occurred, where balls have been quietly lodged in several parts of the body, till after many years they have worked themselves a passage towards the surface, and were very easily extracted; and many cases also where balls have been entirely left behind.

In case the wound be occasioned by a musket or pistol

Wounds. 25 Dilatation of the wound.

stol shot, and of course be small, it will be necessary to dilate the wound without delay, provided the nature of the part will permit of this with safety: for in wounds near a joint, or in very membranous or tendinous parts, the knife, as well as forceps, should be put under some restraint; nor should any more opening be made than what is absolutely requisite for the free discharge of the matter lodged within.

26 Advantage of bleeding.

Where the wounded person has not suffered any great loss of blood, and this is generally the case, it will be advisable to open a vein immediately, and take from the arm a large quantity; and to repeat bleeding as circumstances may require, the second, and even the third day. Repeated bleedings in the beginning are followed by many advantages. They prevent pain and a good deal of inflammation, lessen any feverish assaults, and seldom fail to obviate imposthumations, and a long train of complicated symptoms which are wont otherwise to interrupt the cure, miserably harass the poor patient, and too often endanger his life. Even where the feverish symptoms run high, and there is almost a certainty that matter is forming, bleeding, in such a state, is very frequently of great advantage.

27 Regimen.

For the first twelve days after the wound has been received, it will be proper to observe a cooling regimen, both in respect of the medicines that may be prescribed, and the diet requisite for the support of the patient. It is likewise absolutely necessary that the body be constantly kept open. Unless, therefore, nature does this office of herself, a stool should be every day procured, either by emollient clysters, or some gentle laxative taken at the mouth; and whenever there is much pain in the wounded parts, immediate recourse must be had to opium.

28 External application.

As to external applications, whatever is of a hot spirituous nature is remarkably injurious on these occasions, and what no wounded part can in any degree bear. The wound may be dressed with pledgits of any emollient ointment; the whole being covered with a common poultice, or, in some cases, the preparations of lead may be used. An opiate should now be administered; and the part affected being placed in the easiest and most convenient posture, the patient should be laid to rest. The formation of matter, in every contused wound, is an object of the first importance; for, till this takes place, there is often reason to suspect that gangrene may happen. With a view to hasten suppuration, the warm poultices should be frequently renewed, and they should be continued till the tension and swelling, with which wounds of this kind are usually attended, be removed, and till the sore has acquired a red, healthy, granulating appearance, and then it is to be treated like a common ulcer.

Gun-shot wounds are commonly covered from the beginning with deep sloughs, and various remedies are recommended for removing these. Every appearance, however, of this kind with which they are attended proceeds entirely from contusion; and, excepting the injury be extensive, the slough is not often perceptible, or it is so thin as to come away along with the matter at the first or second dressing. Although emollient poultices be extremely useful, they ought to be no longer continued than till the effects already mentioned are produced; otherwise they will not only relax the parts, but also produce too copious a discharge of matter, which is sometimes attended with great danger. A too copious flow of matter may proceed from different causes; but in whatever way it may have been produced, the practice to be adopted must be nearly the same. Every collection which appears must have a free outlet, and the limb laid in that posture which will most readily admit of its running off. In such circumstances, nourishing diet and Peruvian bark in considerable quantities are highly useful. When the discharge continues copious, in spite of every effort to check it, detached pieces of bone or some extraneous matter are probably the cause. In such a situation nothing will lessen the quantity of matter till such substances be removed. The wound ought therefore again to be examined, and any loose bodies taken away. Pieces of cloth have been known to be removed by setons, when that method was practicable, after every other method had failed. Opium is frequently used in checking an excessive discharge when it happens to be kept up by irritation.

Although no considerable hemorrhagy may happen on first receiving a gun-shot wound; yet after the sloughs commonly produced upon such occasions have come off, some considerable arteries may be exposed, and then a dangerous hemorrhagy may ensue. The hemorrhagy is often preceded by a great heat in the injured parts, and with a throbbing pulsatory pain. At this period it may frequently be prevented by plentiful blood-letting, particularly local. But if the hemorrhagy has fairly taken place, and from arteries of considerable size, nothing will restrain it but the proper application of ligatures. As the discharge in these cases would often prove dangerous before the surgeon could be procured, the attendants should be furnished with a tourniquet, with directions to apply it, upon the first appearance of blood.

Till of late years the scarifying of gun-shot wounds was a practice which prevailed very universally among surgeons; and it was expected by this, that the sloughs with which wounds are sometimes covered would sooner separate, and that the cure would thereby be more readily performed. It is now, however, known, that this practice, instead of being useful, very generally does harm by increasing the inflammation. It should therefore be laid entirely aside. 29 Scarifying improper.

When a gun-shot wound cannot easily or safely be laid open from one end to the other, perhaps it may be proper to introduce a cord through the sinus. This, however, should not be attempted till the first or inflammatory state of the wound is over: but when a cord cannot be properly introduced, on account of the situation or direction of the wound, compression may prove equally useful here as in cases of punctured wounds.

Mortification happening after gun-shot wounds, is to be treated in the same manner as if it had arisen from any other cause, only bark is not to be promiscuously used; as, in plethoric habits, it may prove hurtful, though in debilitated relaxed habits it will be extremely useful; but even in such it should never be given while much pain and tension continue. 30 Mortification.

Of Wounds and Injuries of the Head producing Fractures and Depressions.—When the brain is compressed, a set of symptoms ensue, extremely dangerous, though sometimes they do not make their appearance till after a considerable interval. But at whatever time they appear, they are uniformly of the same kind, and 31 Symptoms of compression of the brain.

are

Wounds.

are in general as follows: drowsiness, giddiness, and stupefaction, dimness of sight, dilatation of the pupil; and, where the injury done to the head is great, there is commonly a discharge of blood from the eyes, nose, or ears. Sometimes the fractured bone can be discovered through the integuments, at other times it cannot. There is an irregular and oppressed pulse, and snoring or apoplectic stertor in breathing. There is likewise nausea and vomiting, with an involuntary discharge of fæces and urine. Among the muscles of the extremities and other parts, there is loss of voluntary motion, convulsive tremors is some parts of the body, and palsy in others, especially in that side of the body which is opposite to the injured part of the head.

Some of the milder of these symptoms, as vertigo, stupefaction, and a temporary loss of sensibility, are frequently induced by slight blows upon the head, but commonly soon disappear, either by rest alone, or by the means to be afterwards pointed out. But when any other symptoms ensue, such as dilatation of the pupils, and especially when much blood is discharged from the eyes, nose, and ears, and that there is an involuntary discharge of fæces and urine, it may be reasonably concluded that compression of the brain is induced.

The cavity of the cranium, in the healthy and natural state, is everywhere completely filled by the brain; whatever therefore diminishes that cavity, will produce a compression of the brain.

32 Causes of these.

The causes producing such a diminution may be of various kinds, as fracture and depression of the bones of the cranium; the forcible introduction of any extraneous body into the cavity of the cranium; effusion of blood, serum, pus, or any other fluid; the thickness and irregularity of the bones of the cranium in certain diseases, as in lues venerea, rickets, or spina ventosa; or water collected in hydrocephalous cases. The first set of causes shall be considered in their order. The four last mentioned belong to the province of the physician, and have been considered in a former part of this work.

Fractures of the cranium have been differently distinguished by different authors; but it seems sufficient to divide them into those attended with depression, and those which are not.

In fracture and depression of the cranium, the treatment ought to be,—to discover the situation and extent of the fracture; and to obviate the effects of the injury done to the brain, by raising or removing all the depressed parts of the bone.

33 Method of discovering the situation of fractures of the cranium.

When the teguments corresponding to the injury done to the bone are cut or lacerated, and, as is sometimes the case, entirely removed, the state of the fracture is immediately discovered; but when the integuments of the skull remain entire, even though the general symptoms of fracture be present, there is sometimes much difficulty in ascertaining it. When, however, any external injury appears, particularly a tumor from a recent contusion, attended by the symptoms already described, there can be no doubt of the existence of a fracture. But it sometimes happens that compression exists without the smallest appearance of tumor. In such cases, the whole head ought to be shaved, when an inflammatory spot may frequently be observed. Sometimes the place of the fracture has been discovered by the patient applying the hand frequently on or near some particular part of the head.

When the symptoms of a compressed brain are evidently marked, no time ought to be lost in setting about an examination of the state of the cranium, wherever appearances point out, or even lead us to conjecture, in what part a fracture may be situated. For this purpose an incision is to be made upon the spot through the integuments to the surface of the bone, which must be sufficiently exposed to admit of a free examination.

Some authors have recommended a crucial incision; others one in form of the letter T; while many advise a considerable part of the integuments to be entirely removed. But as it is more agreeable to the present mode of practice to save as much of the skin as possible, a simple incision is generally preferred, unless the fracture run in different directions, and then the incision must vary accordingly. It will frequently happen, that a considerable part of the integuments must be separated from the skull, in order to obtain a distinct view of the full extent of the fracture; but no part of the integuments is to be entirely removed.

When blood-vessels of any considerable size are divided, either before or in time of the examination, they ought to be allowed to bleed freely, as in no case whatever is the loss of blood attended with more advantage than the present. When, however, it appears that the patient has lost a sufficient quantity, the vessels ought to be secured.

After the integuments have been divided, if the skull be found to be fractured and depressed, the nature of the case is rendered evident; but even where there is no external appearance of fracture, tumor, discoloration, or other injury, if the patient continne to labour under symptoms of a compressed brain, if the pericranium has been separated from the bone, and especially if the bone has lost its natural appearance, and has acquired a pale white or dusky yellow hue, the trepan ought to be applied without hesitation at the place where these appearances mark the principal seat of the injury.

Again, although no mark either of fracture or of any diseases underneath should appear on the outer table of the bone, yet there is a possibility that the inner table may be fractured and depressed. This indeed is not a common occurrence, but it happens probably more frequently than surgeons have been aware of; and where it does happen, the injury done to the brain is as great, and attended with as much danger, as where the whole thickness of the bone is beat in. The application of the trepan is therefore necessary.

But if, after the application of the trepan, it happens that no mark of injury appears either in the outer or inner table in that part, or in the dura mater below it, and that the symptoms of a compressed brain still continue, a fracture in some other part is to be suspected; or that kind of fracture termed by practitioners *counter fissure*, where the skull is fractured and sometimes depressed on the opposite side to, or at a distance from, the part where the injury was received. This is fortunately not a very frequent occurrence, and has even been doubted by some; but different instances of it have, beyond all question, been found. If therefore the operation of the trepan has been performed, and no fracture is

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is discovered, no extravasation appears on the surface of the brain; and if blood-letting and other means usually employed do not remove the symptoms of compression, the operator is to search for a fracture on some other part. The whole head should again be examined with much accuracy; and, by pressing deliberately but firmly over every part of it, if the smallest degree of sensibility remains, the patient will show signs of pain, either by moans or by raising his hands, when pressure is made over the fractured part. In this way fractures have been frequently detected, which might otherwise have been concealed.

34 Method of removing and elevating depressed portions of the cranium.

Having now considered every thing preparatory to the operation of the trepan, we shall next point out the means best adapted for the removal or elevation of a depressed portion of the bone.

The first thing to be done is, after shaving the head, to make an incision as deep as the bone, and directly upon the course of the fracture.

The patient ought to be laid on a table, with a mattress under him, while his head is placed upon a pillow, and secured by an assistant. When the extent of the fracture has been determined, and the bleeding from the incision stopped, the depressed bone is now to be elevated; but previous to this it is necessary to search for detached pieces. Should any be found, they ought to be removed by a pair of forceps adapted to this purpose. By the same instrument any splinters of bone which may have been beaten in may be removed; but when a part of the bone is beaten in beyond the level of the rest of the cranium, as much of the pericranium is then to be removed by a raspatory, as will allow the trephine to be applied; or, if the operator incline, for the sake of dispatch, he may use the trepan; or the operation may be begun and finished with the trephine, while the trepan may perform the middle and principal part of the work. This part of the work is begun by making a hole with the perforator, deep enough to fix the central pin of the trephine, in order to prevent the saw from slipping out of its central course, till it has formed a groove sufficiently deep to be worked steadily in; and then the pin is to be removed. If the bone be thick, the teeth of the saw must be cleaned now and then by the brush during the perforation, and dipped in oil as often as it is cleaned, which will considerably facilitate the motion, and render it more expeditious: making it at the same time much less disagreeable to the patient, if he possess his senses. That no time may be lost, the operator ought to be provided with two instruments of the same size, or at least to have two heads which can be readily fitted to the same handle.

After having made some progress in the operation, the groove ought to be frequently examined with a pick-tooth, or some such instrument, in order to discover its depth; and if one side happen to be deeper than the other, the operator ought to press more on that side which is shallowest. Precautions are more particularly necessary when the operation is performed upon a part of the skull which is of an unequal thickness, especially after the instrument has passed the diploe. And though it be said by writers in general that the instrument may be worked boldly till it comes at the diploe (which is generally known by the appearance of blood), yet the operator should be upon his guard in this point, examining from time to time if the piece be loose, lest through inadvertence the dura mater be wounded; for in some parts of the skull there is naturally very little diploe, and in old subjects scarcely any. It ought likewise to be remembered, that the skulls of children are very thin. When the piece begins to vacillate, it ought to be snapped off with the forceps or levator; for the sawing ought by no means to be continued till the bone be cut quite through, otherwise the instrument may plunge in upon the brain, or at least injure the dura mater (B). If the inner edge of the perforation be left ragged, it is to be smoothed with the lenticular, to prevent it from irritating the dura mater. Particular care is to be taken in using the instrument, lest it should press too much upon the brain.

The next step is to raise the depressed part of the bone with the levator, or to extract the fragments of the bone, grumous blood, or any extraneous body. After this, if there appear reason to apprehend that blood, lymph, or matter, is contained under the dura mater, it ought to be cautiously opened with a lancet, endeavouring to avoid the blood-vessels running upon it, or lying immediately under it.

When the trepan is to be used on account of a fissure in which the bone will not yield, the instrument should be applied so as to include part of it, if not directly over it, as it is most probable that the extravasated fluid will be found directly under it. And when the fissure is of great extent, it may be proper to make a perforation at each end, if the whole can be conveniently brought into view; and in some cases several perforations may become necessary.

When it is proposed to make several perforations to remove depressed fragments of the bone which are firmly fixed, and having the internal surface larger than the external, or to raise them sufficiently, it is necessary to apply the trepan as near the fractured parts as possible; making the perforations join each other, to prevent the trouble of cutting the intermediate spaces.

When the skull is injured over a suture, and it is not thought advisable to use the trepan, a perforation ought to be made on each side of the suture, especially in young subjects, in which the dura mater adheres more strongly than in adults; because there cannot be a free communication between the one side and the other, on account of the attachment of that membrane to the suture.

35 Treatment of the patient after the operation.

After the elevation of the depressed pieces, or the removal of those which are quite loose, the extraction of extraneous bodies, and the evacuation of extravasated fluids, &c. the sore is to be dressed in the lightest and easiest manner; all that is necessary being to apply a pledget of fine scraped lint, covered with simple ointment, to that part of the dura mater which is laid bare by

(B) A trepanning instrument has been invented by Mr Rodman, surgeon, Paisley, which has no central pin, and it is so contrived that any given thickness of bone may be cut, so that the danger from other instruments is by the use of this entirely avoided. See a more detailed account of this instrument under ABAPTISTON.

Wounds. by the trepan, or otherwise; after which the edges of the scalp are to be brought together or nearly so, and another pledget laid along the whole course of the wound; a piece of fine soft linen is to be laid over all, and the dressings may be retained in their place by a common night-cap applied close to the head, and properly fixed.

The patient is to be placed in as easy a position in bed as possible, with his head and shoulders elevated a little more than ordinary. If the operation be attended with success, the patient will soon begin to show favourable symptoms; he will soon show signs of increasing sensibility, and the original bad symptoms will gradually disappear. After this he ought to be kept as quiet as possible; proper laxatives are to be administered, and such as may be least of a nauseating nature. His food ought to be simple and easy of digestion, and his drink of the most diluent kind. If he complain of the wound being uneasy, an emollient poultice should be immediately applied, and renewed three or four times in the twenty-four hours. By these means there will commonly be a free suppuration from the whole surface of the sore.

Every time the wound is dressed, the purulent matter ought to be wiped off from it with a fine warm sponge; and if any degree of sloughiness take place on the dura mater or parts adjacent, it will then be completely separated. Granulations will begin to form, which will continue to increase till the whole arise to a level with the surface of the cranium. The edges of the sore are now to be dressed with cerate straps, and the rest of it covered with fine soft lint, kept gently pressed on by the nightcap properly tied. In this way the cure will go on favourably; luxuriance of granulations will commonly be prevented; the parts will cicatrize kindly; and as the skin has been preserved in making the first incision, the cicatrix will be but little observed.

But things do not always proceed in this favourable manner. Sometimes in a few hours after the operation the patient is seized with a kind of restlessness, tossing his arms, and endeavouring to move himself in bed, while the symptoms of a compressed brain remain nearly the same as formerly. In this case, especially if the pulse be quick and strong, the patient ought to be bled freely, as there will be reason to suspect some tendency to inflammation in the brain. Sometimes, though the trepan has been properly applied, the symptoms are not relieved, on account of extravasated fluids collected internally under the dura mater, or between the pia mater and brain, or in the cavity of the ventricles. The danger in these cases will be in proportion to the depth of the collection. Particular attention therefore ought always to be paid to the state of the dura mater after the perforation has been made. If blood be collected below the dura mater, this membrane will be found tense, dark coloured, elastic, and even livid; in which case, an opening becomes absolutely necessary to discharge the extravasated fluid. Gentle scratches are to be made with a scalpel, till a probe or directory can be introduced; upon which the membrane is to be sufficiently divided in a longitudinal, and sometimes even in a crucial direction, till an outlet to the fluid be given.

After the dura mater has been cut in this manner, there is some danger of the brain protruding at the opening; but the danger from this is not equal to the bad effects arising from effused fluids compressing the brain.

A troublesome and an alarming appearance now and then follows the operation of the trepan; namely, the excrescences called *fungi*, formerly supposed to grow immediately from the surface of the brain, but which, in general, originate from the surface of the dura mater or cut edge of the bone granulating too luxuriantly.

It often happens that they possess little sensibility; and then the best method to prevent their rising to any great height is to touch them frequently with lunar caustic: but some cases occur where their sensibility is so great that they cannot be touched, unless they hang by a small neck; and then a ligature may be put round them, and tightened from time to time till they drop off, which will commonly be in the course of a few days. It seldom happens, however, that there is any occasion for applying such means for the removal of these tumours, for they generally fall off as the perforations of the bone fill up.

If they do not, as the connection between them and the brain will be then in a great measure intercepted, they may be with more safety removed, either by excision, by caustic, or by ligature.

The cure being thus far completed, only a small cicatrix will remain, and in general the parts will be nearly as firm as at first: but when much of the integuments have been separated or destroyed, as they are never regenerated, the bone will be left covered only by a thin cuticle, with some small quantity of cellular substance. When this is the case, the person ought to wear a piece of lead or tin, properly fitted and lined with flannel, to protect it from the cold and other external injuries.

This is the method now commonly practised in cases of compression; but it frequently happens, that instead of compression, such a degree of concussion takes place that no assistance from the trepan can be attended with any advantage; for the effects of concussion are totally different from those of compression, and therefore to be removed in a different manner.

WOUNDS, in *Farriery*. See FARRIERY *Index*.

WRASSE, or OLD WIFE. See LABRUS, ICHTHYOLOGY *Index*.

WREATH, in *Heraldry*, a roll of fine linen or silk (like that of a Turkish turban), consisting of the colours borne in the escutcheon, placed in an achievement between the helmet and the crest, and immediately supporting the crest.

WRECK, or SHIPWRECK, the destruction of a ship by rocks or shallows at sea.

By the ancient common law, where any ship was lost at sea, and the goods or cargo were thrown upon the land, these goods, so wrecked, were judged to belong to the king: for it was held, that, by the loss of the ship, all property was gone out of the original owner. But this was undoubtedly adding sorrow to sorrow, and was consonant neither to reason nor humanity. Wherefore it was first ordained by King Henry I. that if any person escaped alive out of the ship, it should be no wreck; and afterwards King Henry II. by his charter, declared, that if on the coasts of either England, Poictou, Oleron, or Gascony, any ship should be distressed, and

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and either man or beast should escape or be found therein alive, the goods should remain to the owners, if they claimed them within three months; but otherwise should be esteemed a wreck, and should belong to the king, or other lord of the franchise. This was again confirmed with improvements by King Richard I.; who, in the second year of his reign, not only established these concessions, by ordaining that the owner, if he was shipwrecked and escaped, *omnes res suas liberas et quietas haberet*, but also, that if he perished, his children, or, in default of them, his brethren and sisters, should retain the property: and in default of brother or sister, then the goods should remain to the king (A). And the law, as laid down by Bracton in the reign of Henry III. seems still to have improved in its equity. For then, if not only a dog (for instance) escaped, by which the owner might be discovered, but if any certain mark were set on the goods, by which they might be known again, it was held to be no wreck. And this is certainly most agreeable to reason; the rational claim of the king being only founded upon this, that the true owner cannot be ascertained. Afterwards, in the first statute of Westminster, the time of limitation of claims, given by the charter of Henry II. is extended to a year and a day, according to the usage of Normandy: and it enacts, that if any man, a dog, or a cat, escape alive, the vessel shall not be adjudged a wreck. These animals, as in Bracton, are only put for examples; for it is now held, that not only if any live thing escape, but if proof can be made of the property of any of the goods or lading which come to shore, they shall not be forfeited as wreck. The statute further ordains, that the sheriff of the county shall be bound to keep the goods a year and a day (as in France for one year, agreeable to the maritime laws of Oleron, and in Holland for a year and a half), that if any man can prove a property in them, either in his own right or by right of representation, they shall be restored to him without delay; but if no such property be proved within that time, they then shall be the king's. If the goods are of a perishable nature, the sheriff may sell them, and the money shall be liable in their stead. This revenue of wrecks is frequently granted out to lords of manors as a royal franchise; and if any one be thus intitled to wrecks in his own land, and the king's goods are wrecked thereon, the king may claim them at any time, even after the year and day.

It is to be observed, that, in order to constitute a legal wreck, the goods must come to land. If they continue at sea, the law distinguishes them by the barbarous and uncouth appellations of *jetsam*, *flotsam*, and *ligan*. Jetsam is where goods are cast into the sea, and there sink and remain under water: flotsam is where they continue swimming on the surface of the waves: ligan is where they are sunk in the sea, but tied to a cork or buoy, in order to be found again. These are also the king's, if no owner appears to claim them; but if any owner appears, he is intitled to recover the possession. For even if they be cast overboard, without any mark or buoy, in order to lighten the ship, the owner is not by this act of necessity construed to have renounced his property: much less can things ligan be supposed to be abandoned, since the owner has done all in his power to assert and retain his property. These three are therefore accounted so far a distinct thing from the former, that by the king's grant to a man of wrecks, things jetsam, flotsam, and ligan, will not pass.

Wrecks, in their legal acceptation, are at present not very frequent; for if any goods come to land, it rarely happens, since the improvement of commerce, navigation, and correspondence, that the owner is not able to assert his property within the year and day limited by law. And in order to preserve this property entire for him, and if possible to prevent wrecks at all, our laws have made many very humane regulations; in a spirit quite opposite to these savage laws which formerly prevailed in all the northern regions of Europe, and a few years ago were still said to subsist on the coasts of the Baltic sea, permitting the inhabitants to seize on whatever they could get as lawful prize; or, as an author of their own expresses it, "*in naufragorum miseria et calamitate tanquam vultures ad prædam currere.*" For by the statute 27 Edw. III. c. 13. if any ship be lost on the shore, and the goods come to land (which cannot, says the statute, be called *wreck*), they shall be presently delivered to the merchants, paying only a reasonable reward to those that saved and preserved them, which is intitled *salvage*. Also by the common law, if any persons (other than the sheriff) take any goods so cast on shore, which are not legal wreck, the owners might have a commission to inquire and find them out, and compel them to make restitution. And by 12 Ann. stat. 2. c. 18. confirmed by 4 Geo. I. c. 12. in order to assist the distressed, and prevent the scandalous illegal practices on some of our sea-coasts (too similar to those on the Baltic), it is enacted, that all head-officers and others of towns near the sea, shall, upon application made to them, summon as many hands as are necessary, and send them to the relief of any ship in distress, on forfeiture of 100l.; and in case of assistance given, salvage shall be paid by the owners, to be assessed by three neighbouring justices. All persons that secrete any goods shall forfeit their treble value; and if they wilfully do any act whereby the ship is lost or destroyed, by making holes in her, stealing her pumps, or otherwise, they are guilty of felony without benefit of clergy. Lastly, by the statute of 26 Geo. II. c. 19. plundering any vessel, either in distress or wrecked, and whether any living creature be on board or not (for whether wreck or otherwise, it is clearly not the property of the populace), such plundering or preventing the escape of any person that endeavours to save his life, or wounding him with intent to destroy him, or putting out false lights in order to bring any vessel into danger, are all declared to be capital felonies; in like manner as the destroying of trees, steeples, or other stated sea-marks, is

(A) In like manner Constantine the Great, finding that by the imperial law the revenue of wrecks was given to the prince's treasury or fiscus, restrained it by an edict (Cod. 11. 5. 1.) and ordered them to remain to the owners; adding this humane expostulation: "Quod enim jus habet fiscus in aliena calamitate, ut de re tam luctuosa compendium sectetur."

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is punished by the statute 8 Eliz. c. 13. with a forfeiture of 100l. or outlawry. Moreover, by the statute of Geo. II. pilfering any goods cast ashore is declared to be petty larceny; and many other salutary regulations are made, for the more effectually preserving ships of any nation in distress.

By the civil law, to destroy persons shipwrecked, or prevent their saving the ship, is capital. And to steal even a plank from a vessel in distress or wrecked, makes the party liable to answer for the whole ship and cargo. The laws also of the Wisigoths, and the most early Neapolitan constitutions, punished with the utmost severity all those who neglected to assist any ship in distress, or plundered any goods cast on shore.

WREN. See Motacilla, Ornithology *Index*.

Wren, *Sir Christopher*, a great philosopher, and one of the most learned and most eminent architects of his age, was the son of Christopher Wren dean of Windsor, and was born in 1632. He studied at Wadham college in Oxford; where he took the degree of master of arts in 1653, and was chosen fellow of All-Souls college. When very young he discovered a surprising genius for the mathematics; in which science he made great advances before he was sixteen years old. In 1657, he was made professor of astronomy at Gresham college, London; which he resigned in 1660, on his being chosen to the Savilian professorship of astronomy in Oxford: he was next year created doctor of laws, and in 1663 was elected fellow of the Royal Society. He was one of the commissioners for the reparation of St Paul's; and in 1665 travelled into France, to examine the most beautiful edifices there, when he made many curious observations. At his return to England, he drew a noble plan for rebuilding the city of London after the fire, which he presented to parliament; and upon the decease of Sir John Denham in 1668, was made surveyor-general of his majesty's works; and from that time had the direction of a great number of public edifices, by which he acquired the highest reputation. He built the magnificent theatre at Oxford, St Paul's cathedral, the churches of St Stephen Walbrook, and St Mary-le-Bow, the Monument, the modern part of the palace of Hampton Court, Chelsea college, one of the wings of Greenwich hospital, and many other beautiful edifices. He was president of the Royal Society, one of the commissioners of Chelsea college, and twice member of parliament; first for Plymouth in Devonshire, and then for Melcomb Regis in the same county; but in 1718 was removed from his place of surveyor-general. He died in 1723, and was interred in the vault under St Paul's.

This great man also distinguished himself by many curious inventions and discoveries in natural philosophy; and, among many others, contrived an instrument for measuring the quantity of rain that falls on any space of land for a year; he invented many ways of making astronomical observations more accurate and easy; and was the first author of the anatomical experiment of injecting liquors into the veins of animals, &c. He translated into Latin Mr Oughtred's *Horologiographia Geometrica*; and wrote a Survey of the cathedral church of Salisbury, and other pieces. After his death his posthumous works and draughts were published by his son.

WRESTLING, a kind of combat or engagement between two persons unarmed, body to body, to prove their strength and dexterity, and try which can throw his opponent to the ground.

Wrestling is an exercise of very great antiquity and fame. It was in use in the heroic age; witness Hercules, who wrestled with Antæus.

It continued a long time in the highest repute, and had considerable rewards and honours assigned to it at the Olympic games. It was the custom for the athletæ to anoint their bodies with oil, to give the less hold to their antagonists.

Lycurgus ordered the Spartan maids to wrestle in public quite naked, in order, as it is observed, to break them of their too much delicacy and niceness, to make them appear more robust, and to familiarize the people, &c. to such nudities.

WRIST, in *Anatomy*. See there, N° 53.

WRIT, in *Law*, signifies, in general, the king's precept in writing under seal, issuing out of some court, directed to the sheriff or other officer, and commanding something to be done in relation to a suit or action, or giving commission to have the same done. And, according to Fitzherbert, a writ is said to be a formal letter of the king in parchment, sealed with his seal, and directed to some judge, officer, or minister, &c. at the suit of a subject, for the cause briefly expressed, which is to be determined in the proper court according to law.

Writs, in civil actions, are either original or judicial: original, are such as are issued out of the court of chancery for the summoning of a defendant to appear, and are granted before the suit is commenced, in order to begin the same; and judicial writs issue out of the court where the original is returned, after the suit is begun. See Process.

The original writ is the foundation of the suit. See Suit.

When a person hath received an injury, and thinks it worth his while to demand a satisfaction for it, he is to consider with himself, or take advice, what redress the law has given for that injury; and thereupon is to make application or suit to the crown, the fountain of all justice, for that particular specific remedy which he is determined or advised to pursue. As for money due on bond, an action of debt; for goods detained without force, an action of *detenue* or *trover*; or, if taken with force, an action of *trespass vi et armis*; or, to try the title of lands, a writ of entry or action of trespass in ejectment; or for any consequential injury received, a special action on the case. To this end he is to sue out, or purchase by paying the stated fees, an *original* or original writ from the court of chancery, which is the *officina justitiæ*, the shop or mint of justice, wherein all the king's writs are framed. It is a mandatory letter from the king in parchment, sealed with his great seal, and directed to the sheriff of the county wherein the injury is committed, or supposed so to be, requiring him to command the wrong-doer, or party accused, either to do justice to the complainant, or else to appear in court, and answer the accusation against him. Whatever the sheriff does in pursuance of this writ, he must return or certify to the court of common pleas, together with the writ itself: which is the foundation of the jurisdiction of that court, being the king's warrant for the judges to proceed to the determination of the cause. For it was a maxim introduced by the Normans, that there should be

Writs. be no proceedings in common-pleas before the king's justices without his original writ; because they held it unfit that those justices, being only the substitutes of the crown, should take cognizance of any thing but what was thus expressly referred to their judgment. However, in small actions, below the value of forty shillings, which are brought in the court-baron or county-court, no royal writ is necessary; but the foundation of such suits continue to be (as in the times of the Saxons), not by original writ, but by plaint; that is, by a private memorial tendered in open court to the judge, wherein the party injured sets forth his cause of action: and the judge is bound of common right to administer justice therein, without any special mandate from the king. Now indeed even the royal writs are held to be demandable of common right, on paying the usual fees: for any delay in the granting them, or setting an unusual or exorbitant price upon them, would be a breach of magna charta, c. 29. "nulli vendemus, nulli negabimus, aut differemus justitiam vel rectum."

Original writs are either optional or peremptory; or, in the language of our law, they are either a *præcipe* or a *si te fecerit securum*. The *præcipe* is in the alternative, commanding the defendant to do the thing required, or show the reason wherefore he hath not done it. The use of this writ is where something certain is demanded by the plaintiff, which is in the power of the defendant himself to perform; as, to restore the possession of land, to pay a certain liquidated debt, to perform a specific covenant, to render an account, and the like; in all which cases the writ is drawn up in the form of a *præcipe* or command, to do thus, or show cause to the contrary; giving the defendant his choice to redress the injury or stand the suit. The other species of original writs is called a *si fecerit te securum*, from the words of the writ; which directs the sheriff to cause the defendant to appear in court, without any option given him, provided the plaintiff gives the sheriff security effectually to prosecute his claim. This writ is in use where nothing is specifically demanded, but only a satisfaction in general; to obtain which, and minister complete redress, the intervention of some judicature is necessary. Such are writs of trespass, or on the case, wherein no debt or other specific thing is sued for in certain, but only damages to be assessed by a jury. For this end the defendant is immediately called upon to appear in court, provided the plaintiff gives good security of prosecuting his claim. Both species of writs are tested or witnessed, in the king's own name; "witness ourself at Westminster", or wherever the chancery may be held.

The security here spoken of, to be given by the plaintiff for prosecuting his claim is common to both writs, though it gives denomination only to the latter. The whole of it is at present become a mere matter of form; and John Doe and Richard Roe are always returned as the standing pledges for this purpose.—The ancient use of them was to answer for the plaintiff, who in case he brought an action without cause, or failed in the prosecution of it when brought, was liable to an amercement from the crown for raising a false accusation; and so the form of the judgment still is. In like manner, as by the Gothic constitutions no person was permitted to lay a complaint against another *nisi sub scriptura aut specificatione trium testium, quod actionem vellet persequi*: and, as by the laws of Sancho I. king of Portugal, damages were given against a plaintiff who prosecuted a groundless action.

Writs, Writing.

The day on which the defendant is ordered to appear in court, and on which the sheriff is to bring in the writ, and report how far he has obeyed it, is called the *return of the writ*; it being then returned by him to the king's justices at Westminster. And it is always made returnable at the distance of at least 15 days from the date or test, that the defendant may have time to come up to Westminster, even from the most remote parts of the kingdom; and upon some day in one of the four terms, in which the court sits for the dispatch of business.

WRITING, the art or act of signifying and conveying our ideas to others, by letters or characters visible to the eye. See COMPOSITION, GRAMMAR, and LANGUAGE.

The most ancient remains of writing, which have been transmitted to us, are upon hard substances, such as stones and metals, which were used by the ancients for edicts and matters of public notoriety; the decalogue was written on two tables of stone; but this practice was not peculiar to the Jews, for it was used by most of the eastern nations, as well as by the Greeks and Romans; and therefore the ridicule which Voltaire attempts to cast upon that part of the book of Genesis, where the people are commanded to write the law on stones, is absurd; for what is there said by no means implies, that other materials might not be used on common occasions. The laws penal, civil, and ceremonial, among the Greeks, were engraven on tables of brass which were called *cyrbes*.

We find that wood was also used for writing on in different countries. In the Sloanian library (N° 4852.) are six specimens of Kufic writings, on boards about two feet in length, and six inches in depth. The Chinese, before the invention of paper, wrote or engraved with an iron tool upon thin boards or on bamboo. Pliny says, that table books of wood were in use before the time of Homer. These table books were called by the Romans *pugillares*. The wood was cut into thin slices, and finely plained and polished. The writing was at first upon the bare wood, with an iron instrument called a *style*. In latter times these tables were usually waxed over, and written upon with that instrument. The matter written upon the tables which were thus waxed over was easily effaced, and by smoothing the wax new matter might be substituted in the place of what had been written before. The Greeks and Romans continued the use of waxed table-books long after the use of papyrus, leaves, and skins, became common, because they were so convenient for correcting extemporary compositions.

Table books of ivory are still used for memorandums, but they are commonly written upon with black lead pencils. The practice of writing on table-books covered with wax was not entirely laid aside till the commencement of the 14th century.

The bark of trees was also used for writing by the ancients, and is so still in several parts of Asia. The same thing may be said of the leaves of trees. It is needless to observe the use of parchment and vellum, papyrus and paper, for writing; it is too well known.

The method of fabricating these substances has been already described as they occurred in the order of the alphabet.

It is obvious, that when men wrote, or rather engraved, on hard substances, instruments of metal were necessary, such as the chisel and the stylus; but the latter was chiefly used for writing upon boards, waxed tablets, or on bark.

When the ancients wrote on softer materials than wood or metal, other instruments were used for writing with, of which reeds and canes seem to have been the first. Reeds and canes are still used as instruments for writing with by the Tartars, the Indians, the Persians, the Turks, and the Greeks. Pencils made of hair are used by the Chinese for their writing: they first liquefy their ink, and dip their pencils into it. Hair-pencils have likewise been used for writing in Europe. Large capital letters were made with them from the time of the Roman emperors till the 16th century. After the invention of printing they were drawn by the illuminators. Quills of geese, swans, peacocks, crows, and other birds, have been used in these western parts for writing with, but how long is not easy to ascertain. St Isidore of Seville, who lived about the middle of the 7th century, describes a pen made of a quill as used in his time.

Method of restoring decayed WRITINGS. In the 77th volume of the Phil. Trans. there is a paper on this subject by Sir Charles Blagden. One of the best methods he found upon experiment to be, covering the letters with phlogisticated or prussic alkali, with the addition of a diluted mineral acid; upon the application of which, the letters changed very speedily to a deep blue colour, of great beauty and intensity. To prevent the spreading of the colour, which, by blotting the parchment, detracts greatly from the legibility, the alkali should be put on first, and the diluted acid added upon it. The method found to answer best has been, to spread the alkali thin with a feather over the traces of the letters, and then to touch it gently, as nearly upon or over the letters as can be done with the diluted acid, by means of a feather or a bit of stick cut to a blunt point. Though the alkali should occasion no sensible change of colour, yet the moment the acid comes upon it, every trace of a letter turns at once to a fine blue, which soon acquires its full intensity, and is beyond comparison stronger than the colour of the original trace had been. If, then, the corner of a bit of blotting paper be carefully and dexterously applied near the letters, so as to imbibe the superfluous liquor, the staining of the parchment may be in a great measure avoided; for it is this superfluous liquor which, absorbing part of the colouring matter from the letters, becomes a dye to whatever it touches. Care must be taken not to bring the blotting paper in contact with the letters, because the colouring matter is soft whilst wet, and may easily be rubbed off. The acid chiefly employed was the marine; but both the vitriolic and nitrous succeed very well. They should be so far diluted as not to be in danger of corroding the parchment, after which the degree of strength does not seem to be a matter of much nicety.

WRITTEN MOUNTAINS. See MOUNTAINS.

WRY-NECK. See JYNX, ORNITHOLOGY *Index*.

WURTEMBERG, or WIRTEMBERG, formerly a duchy, now a kingdom in Germany. It is surrounded on all sides by the territories of Baden and Bavaria, except at the point where it touches the lake of Constance. It consists chiefly of the basin or valley of the Neckar, but a small part of it extends across the Danube. Its greatest length from south to north is 145 miles, its breadth from east to west 90, and its area amounts to 8,200 square English miles. Wurtemberg is one of the most populous countries in Germany, the number of inhabitants in 1818 being 1,395,463, or 170 on an average to each square mile.

Great numbers of emigrants leave this state annually for America or Russia. The country is hilly in the south, where it embraces part of a low range of mountains called the Black-forest, and some subordinate branches of the Alps, but presents generally an undulating surface in the north. It is, upon the whole, one of the most fertile districts of Germany. Besides wheat, oats, barley, maize, rye, hemp, and potatoes, it produces tobacco, fruits of many kinds, and vines, which are cultivated to a great extent, and yield a wine of superior quality. A considerable number of sheep, and a still greater proportion of black cattle are fed in the Black forest, and other hilly districts. These districts also furnish abundance of wood. There are mines of silver, copper, cobalt and iron, but not so productive as to supply the internal consumption. There are also manufactures of linens and woollens; a few of cotton, with some of leather and iron.

The inhabitants are Lutherans, with a small intermixture of Catholics. They are said to be distinguished from the other Germans by a greater share of vivacity, frankness, and good humour, but not by greater sobriety or industry. Their dialect is taxed with rudeness, but they can boast of having produced many writers of acknowledged merit. There is no part of Germany so well supplied with schools, not only for elementary instruction, but also for the learned languages. The people are in short extremely well informed; and the effects of their superior intelligence have been lately seen in the manly struggle they maintained, since the year 1815, for the restoration of their ancient privileges, which were abolished during the ascendancy of Bonaparte. Under their ancient constitution, the diet consisted of a house of prelates (for there were no nobles) representing certain abbeys, provostships, and Lutheran convents; and a house of deputies chosen by the towns. This diet met only on extraordinary occasions, but it appointed a great and a little committee, which held two or three sessions in the year; and through these committees it not only decided upon all taxes proposed, but controlled every branch of the administration, and even nominated one-third of the judges. The king offered his subjects a new constitution in 1816, but this was considered less liberal than their old one, and it experienced so much opposition that he was obliged to withdraw it. During the present year (1819) the differences between the contending parties have been adjusted by another constitution proposed by the king and accepted by the people; and which may therefore be presumed to be more favourable to popular rights, though we have not seen the specific articles of which it consists.

Wurtemberg has been greatly enlarged during the recent changes in Germany. In 1796 its surface was estimated at 3200 square English miles, and its inhabitants at 608,697; which is less than one half of its present

Wurtzburg, Wycherley.

present extent and population. It was indebted for the greater part of its acquisitions to Bonaparte; who also bestowed the title of king upon the duke in 1806. Stutgard is the chief town.

WURTSBURG, a large bishopric in Germany, situated on the Maine, erected into a dukedom in 1806, and given to Bavaria in 1814 as a compensation for Salzburg.

WURTZBURG, a large and handsome city of Germany, containing about 21,000 inhabitants. It is defended with good fortifications, and has a magnificent palace. There is a handsome hospital, in which are generally 400 poor men and women. The castle is at a small distance from the city, and commands it, as it stands upon an eminence. It communicates with the city by a stone bridge, on which are 12 statues, representing as many saints. There are manufactures of woollens, glass, leather, chemical substances, &c. There is also an university, founded in 1403. It is seated on the river Maine, in E. Long. 9. 48. N. Lat. 49. 40.

WYCHERLEY, William, an eminent English comic poet, was born about 1640. A little before the restoration of King Charles II. he became a gentleman commoner of Queen's college Oxford, where he was reconciled by Dr Barlow to the Protestant religion, which he had a little before abandoned in his travels. He afterwards entered himself in the Middle-temple, but soon quitted the study of the law for pursuits more agreeable to his own genius, as well as to the taste of the age. Upon writing his first play, entitled, Love in a Wood, or St James's Park, which was acted in 1672, he became acquainted with several of the celebrated wits both of the court and town, and likewise with the duchess of Cleveland. Some time after appeared his comedies, called The Gentleman Dancing Master, the Plain Dealer, and the Country Wife; all which were acted with applause. George duke of Buckingham had a very high esteem for him, and bestowed on him several advantageous posts. King Charles also showed him signal marks of favour; and once gave him a proof of his esteem, which perhaps never any sovereign prince before had given to a private gentleman. Mr Wycherley being ill of a fever, at his lodgings in Bow-street, the king did him the honour of a visit. Finding him extremely weakened, he commanded him to take a journey to the south of France, and assured him, at the same time, that he would order him 500l. to defray the charges of the journey. Mr Wycherley accordingly went into France; and having spent the winter there, returned to England entirely restored to his former vigour. The king, shortly after his arrival, told him, that he had a son, who he was resolved should be educated like the son of a king, and that he could not choose a more proper man for his governor than Mr Wycherley; for which service 1500l. *per annum* should be settled upon him.

Immediately after this offer he went to Tunbridge, where walking one day upon the Well's walk with his friend Mr Fairbeard of Gray's Inn, just as he came up to the bookseller's shop, the countess of Drogheda, a young widow, rich, noble, and beautiful, came there to inquire for the Plain Dealer; "Madam," says Mr Fairbeard, "since you are for the Plain Dealer, there he is for you;" pushing Mr Wycherley towards her. "Yes," says Mr Wycherley, "this lady can bear plain dealing; for she appears to be so accomplished, that what would be a compliment to others, would be plain dealing to her." "No, truly, Sir," said the countess "I am not without my faults, any more than the rest of my sex; and yet notwithstanding, I love plain dealing, and am never more fond of it than when it tells me of them." "Then, madam," says Mr Fairbeard, "you and the Plain Dealer seem designed by Heaven for each other."—In short, Mr Wycherley walked a turn or two with the countess, waited upon her home, visited her daily while she staid at Tunbridge, and married her soon after without acquainting the king. By this step, which was looked upon as a contempt of his majesty's orders, he forfeited the royal favour. The countess of Drogheda settled her whole fortune upon him; but his title being disputed after her death, he was so reduced by the expences of the law and other incumbrances, as to be unable to satisfy the impatience of his creditors, who threw him into prison; and the bookseller who printed his Plain Dealer, by which he got almost as much money as the other gained reputation, was so ungrateful as to refuse to lend him 20l. in his extreme necessity. In that confinement he languished seven years; but at length King James going to see the above play, was so charmed with it, that he gave immediate orders for the payment of his debts, and even granted him a pension of 200l. *per annum*. But the prince's bountiful intentions were in a great measure defeated merely through Mr Wycherley's modesty; he being ashamed to tell the earl of Mulgrave, whom the king had sent to demand it, a true state of his debts. He laboured under the weight of these difficulties till his father died, who left him 600l. a-year. But this estate was under limitations, he being only a tenant for life, and not being allowed to raise any money for the payment of his debts. However, he took a method of doing it which few suspected to be his choice; and this was making a jointure. He had often declared, that he was resolved to die married, though he could not bear the thoughts of living in that state again: accordingly, just at the eve of his death, he married a young gentlewoman with 1500l. fortune, part of which he applied to the uses he wanted it for. Eleven days after the celebration of these nuptials, in December 1715, he died, and was interred in the vault of Covent-garden church.

Wycherley ‖ Wye.

Besides his plays above mentioned, he published a volume of poems in folio. In 1728 his posthumous works in prose and verse were published by Mr Theobald.

WYNDHAM, Sir William, descended of an ancient family, was born about the year 1687, and succeeded young to the title and estate of his father. On his return from his travels, he was chosen member for the county of Somerset; in which station he served in the three last parliaments of Queen Anne, and as long as he lived: after the change of the ministry in 1710, he was appointed secretary at war; and in 1713 was raised to be chancellor of the exchequer. Upon the breach between the earl of Oxford and Lord Bolingbroke, he adhered to the interests of the latter. He was removed from his employment on the accession of George I. and falling under suspicion on the breaking-out of the rebellion in 1715, was apprehended. He made his escape; a reward was published for apprehending him; he surrendered, was committed to the Tower, but never brought to a trial. After he regained his liberty, he continued in opposition to the several administrations under which he lived; and died in 1740.

WYE,

Wye.

WYE, a river of South Wales, which issuing out of Plinlymmon Hill, very near the source of the Severn, crosses the north-east corner of Radnorshire, giving name to the town of Rhyadergowy (Fall of the Wye), where it is precipitated in a cataract: then flowing between this county and Brecknockshire, it crosses Herefordshire, and dividing the counties of Gloucester and Monmouth, falls into the mouth of the Severn, below Chepstow. The romantic beauties of the Wye, which flows in a deep bed, between lofty rocks clothed with hanging woods, and here and there crowned by ruined castles, have employed the descriptive powers of the pen and pencil.

WYE is also the name of a river in Derbyshire, which rises in the north-west part, above Buxton; and, flowing south-east, falls into the Derwent, below Bakewell.

WYE, the name of a town in Kent, with a market on Thursday, seated on the Stour, 10 miles south of Canterbury, and 59 south-east of London. E. Long. 1. 4. N. Lat. 51. 10.

WYE, a town of Switzerland, in a territory of the abbey of St Gallen, with a palace. It is built on an eminence, 16 miles south-south-west of Constance. E. Long. 9. 4. N. Lat. 47. 34.

X.

X
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Xebec.

X, or x, is the 22d letter of our alphabet, and a double consonant. It was not used by the Hebrews or ancient Greeks; for, as it is a compound letter, the ancients, who used great simplicity in their writings, expressed this letter by its component letters *cs*. Neither have the Italians this letter, but express it by *ss*. X begins no word in our language but such as are of Greek original; and is in few others but what are of Latin derivation; as *perplex*, *reflexion*, *defluxion*, &c. We often express this sound by single letters, as *cks*, in *backs*, *necks*; by *ks*, in *books*, *breaks*; by *cc*, in *access*, *accident*; by *ct*, in *action*, *unction*, &c. The English and French pronounce it like *cs* or *ks*; the Spaniards like *c* before *a*, viz. *Alexandro*, as it were *Alecandro*. In numerals it expresseth 10, whence in old Roman manuscripts it is used for *denarius*; and as such seems to be made of two V's placed one over the other. When a dash is added over it, thus $\bar{X}$, it signifies 10,000.

XANTHIUM, a genus of plants of the class *monoecia*, and arranged in the natural classification under the 49th order, *Compositæ*. See BOTANY *Index*.

XANTHOXYLUM. See ZANTHOXYLUM.

XEBEC, or ZEBEC, a small three-masted vessel, navigated in the Mediterranean sea, and on the coasts of Spain, Portugal, and Barbary. See Plate. CCCCLXXXII. fig. 10.

The sails of the xebec are in general similar to those of the poleacre, but the hull is extremely different from that and almost every other vessel. It is furnished with a strong prow: and the extremity of the stern, which is nothing more than a sort of railed platform or galley, projects farther behind the counter and buttock than that of any European ship.

Being generally equipped as a corsair, the xebec is constructed with a narrow floor, to be more swift in pursuit of the enemy; and of a great breadth, to enable her to carry a greater force of sail for this purpose without danger of overturning. As these vessels are usually very low built, their decks are formed with a great convexity, from the middle of their breadth towards the sides in order to carry off the water which falls aboard more readily by their scuppers. But as this extreme convexity would render it very difficult to walk thereon at sea, particularly when the vessel rocks by the agitation of the waves, there is a platform of grating extending along the deck from the sides of the vessel towards the middle, whereon the crew may walk dry-footed whilst the water is conveyed through the grating to the scuppers.

The xebecs, which are generally armed as vessels of war by the Algerines, mount from 16 to 24 cannon, and carry from 300 to 450 men, two-thirds of whom are generally soldiers.

By the very complicated and inconvenient method of working these vessels, what one of their captains of Algiers told Mr Falconer will be readily believed, viz. that every xebec requires at least the labour of three square-rigged ships, wherein the standing sails are calculated to answer every situation of the wind.

XENOCRATES, a celebrated ancient Grecian philosopher, was born at Chalcedon in the 95th Olympiad. At first he attached himself to Æschines, but afterwards became a disciple of Plato, who took much pains in cultivating his genius, which was naturally heavy. His temper was gloomy, his aspect severe, and his manners little tinctured with urbanity. These material defects his master took great pains to correct; frequently advising him to sacrifice to the Graces: and the pupil was patient of instruction, and knew how to value the kindness of his preceptor. As long as Plato lived, Xenocrates was one of his most esteemed disciples; after his death he closely adhered to his doctrine; and in the second year of the 110th Olympiad, he took the chair in the academy, as the successor of Speusippus.

Xenocrates was celebrated among the Athenians, not only for his wisdom, but for his virtues. So eminent was his reputation for integrity, that when he was called upon to give evidence in a judicial transaction, in which an oath was usually required, the judges unanimously agreed, that his simple asseveration should be taken, as a public testimony to his merit. Even Philip of Macedon found it impossible to corrupt him. So abstemious was he with respect to food, that his provision was frequently spoiled before it was consumed. He chastity was invincible. Phryne, a celebrated Athenian courtezan, attempted without success to seduce him. Of his humanity the following pathetic incident is a sufficient proof: A sparrow, which was pursued by a hawk, flew into his bosom; he afforded it protection till its enemy was out of sight, and then let it go, saying, that he would never betray a suppliant. He was fond of retirement, and was seldom seen in the city. He was discreet in the use of his time, and carefully allotted a certain portion of each day

day to its proper business. One of these he employed in silent meditation. He was an admirer of the mathematical sciences; and was so fully convinced of their utility, that when a young man, who was unacquainted with geometry and astronomy, desired admission into the academy, he refused his request, saying, that he was not yet possessed of the handles of philosophy. In fine, Xenocrates was eminent both for the purity of his morals and for his acquaintance with science, and supported the credit of the Platonic school, by his lectures, his writings, and his conduct. He lived to the first year of the 116th Olympiad, or the 82d of his age, when he lost his life by accidentally falling, in the dark, into a reservoir of water.

XENOPHANES, the founder of the Eleaic sect of philosophy among the Greeks, was born at Colophon probably about the 65th Olympiad. From some cause or other he left his country early, and took refuge in Sicily, where he supported himself by reciting, in the court of Hiero, elegiac and iambic verses, which he had written in reprehension of the theogonies of Hesiod and Homer. From Sicily he passed over into Magna Græcia, where he took up the profession of philosophy, and became a celebrated preceptor in the Pythagorean school. Indulging, however, a greater freedom of thought than was usual among the disciples of Pythagoras, he ventured to introduce new opinions of his own, and in many particulars to oppose the doctrines of Epimenides, Thales, and Pythagoras. Xenophanes possessed the Pythagorean chair of philosophy about seventy years, and lived to the extreme age of an hundred years, that is, according to Eusebius, till the 81st Olympiad. The doctrine of Xenophanes concerning nature is so imperfectly preserved, and obscurely expressed, that it is no wonder that it has been differently represented by different writers. Perhaps the truth is, that he held the universe to be one in nature and substance, but distinguished in his conception between the matter of which all things consist, and that latent divine force which, though not a distinct substance but an attribute, is necessarily inherent in the universe, and is the cause of all its perfection.

XENOPHON, an illustrious philosopher, general, and historian, was born at Athens in the third year of the 82d Olympiad. When he was a youth, Socrates, struck with his external appearance, determined to admit him into the number of his pupils. Meeting him by accident in a narrow passage, the philosopher put his staff across the path, and stopping him, asked, where those things were to be purchased which are necessary to human life? Xenophon appearing at a loss for a reply to this unexpected salutation, Socrates proceeded to ask him, where honest and good men were to be found? Xenophon still hesitating, Socrates said to him, "Follow me, and learn." From that time Xenophon became a disciple of Socrates, and made a rapid progress in that moral wisdom for which his master was so eminent. Xenophon accompanied Socrates in the Peloponnesian war, and fought courageously in defence of his country. He afterwards entered into the army of Cyrus as a private volunteer in his expedition against his brother. This enterprise proving unfortunate, Xenophon, after the death of Cyrus, advised his fellow soldiers to attempt a retreat into their own country. They listened to his advice; and having had many proofs of his wisdom as well as courage, they gave him the command of the army, in the room of Proxenus who had fallen in battle. In this command he acquired great glory by the prudence and firmness with which he conducted them back, through the midst of innumerable dangers, into their own country. The particulars of this memorable adventure are related by Xenophon himself in his Retreat of the Ten Thousand. After his return into Greece, he joined Agesilaus, king of Sparta, and fought with him against the Thebans in the celebrated battle of Chæronea. The Athenians, displeased at this alliance, brought a public accusation against him for his former conduct in engaging in the service of Cyrus, and condemned him to exile. The Spartans, upon this, took Xenophon, as an injured man, under their protection, and provided him a comfortable retreat at Scilluntes in Elea. Here, with his wife and two children, he remained several years, and passed his time in the society of his friends, and in writing those historical works which have rendered his name immortal. A war at length arose between the Spartans and Eleans; and Xenophon was obliged to retire to Lepreus, where his eldest son had settled. He afterwards removed, with his whole family, to Corinth, where, in the first year of the hundred and fifth Olympiad, he finished his days.

XENOPHON the *Younger*, a Greek writer, so called to distinguish him from the celebrated Xenophon, was born at Ephesus, and lived, according to some authors, before Heliodorus, that is, about the beginning of the 4th century. He is only known by his *Ephesiaca*, a Greek romance in five books, which is esteemed, and contains the amours or adventures of Abracomes and Anthia. This romance was printed at London, in Greek and Latin, in 1724, 4to.

XERXES I. the fifth king of Persia, memorable for the vast army he is said to have carried into the field against Leonidas king of Sparta; consisting, according to some historians, of 800,000 men, while others make it amount to 3,000,000, exclusive of attendants. The fleet that attended this prodigious land force is likewise made to consist of 2000 sail; and all the success they met with was the taking and burning the city of Athens; for the army was shamefully repulsed near the straits of Thermopylæ by Leonidas, and the fleet was dispersed and partly destroyed by Themistocles at the straits of Salamis, who had only 380 sail under his command. Xerxes was assassinated by Artabanes, chief captain of his guards, and his distinguished favourite. See SPARTA.

XIMENES, FRANCIS, a justly celebrated cardinal, bishop of Toledo, and prime minister of Spain, was born at Torrelaguna, in Old Castile, in 1437, and studied at Alcala and Salamanca. He then went to Rome; and being robbed on the road, brought nothing back but a bull for obtaining the first vacant prebend: but the archbishop of Toledo refused it him, and threw him into prison. Being at length restored to liberty, he obtained a benefice in the diocese of Siguença, where Cardinal Gonzales de Mendoza, who was the bishop, made him his grand vicar. Ximenes some time after entered among the Franciscans of Toledo; but being there troubled with visits, he retired to a solitude named *Castanel*, and applied himself to the study of divinity and the oriental tongues. At his return to Toledo, Queen Isabella of Castile chose him for her confessor, and afterwards nominated him archbishop of Toledo; which, next to the papacy, is the richest dignity in the church of Rome. "This honour (says Dr Robertson) he declined with a firmness

Ximenes.

firmness which nothing but the authoritative injunction of the pope was able to overcome. Nor did this height of promotion change his manners. Though obliged to display in public that magnificence which became his station, he himself retained his monastic severity. Under his pontifical robes he constantly wore the coarse frock of St Francis, the rents of which he used to patch with his own hands. He at no time used linen, but was commonly clad in hair-cloth. He slept always in his habit; most frequently on the floor or on boards, and rarely in a bed. He did not taste any of the delicacies which appeared at his table, but satisfied himself with that simple diet which the rule of his order prescribed. Notwithstanding these peculiarities, so opposite to the manner of the world, he possessed a thorough knowledge of its affairs, and discovered talents for business which rendered the fame of his wisdom equal to that of his sanctity." His first care was to provide for the necessities of the poor; to visit the churches and hospitals; to purge his diocese of usurers and places of debauchery; to degrade corrupt judges, and place in their room persons whom he knew to be distinguished by their probity and disinterestedness. He erected a famous university at Alcala; and in 1499 founded the college of St Ildephonso. Three years after he undertook the Polyglot Bible; and for that purpose sent for many learned men to come to him at Toledo, purchased seven copies in Hebrew for 4000 crowns, and gave a great price for Latin and Greek manuscripts. At this Bible they laboured above 12 years. It contains the Hebrew text of the Bible; the version of the Septuagint, with a literal translation; that of St Jerom, and the Chaldee paraphrases of Onkelos; and Ximenes added to it a dictionary of the Hebrew and Chaldee words contained in the Bible. This work is called *Ximenes's Polyglot*. In 1507 Pope Julius II. gave him the cardinal's hat, and King Ferdinand the Catholic entrusted him with the administration of affairs. Cardinal Ximenes was from this moment the soul of every thing that passed in Spain. He distinguished himself at the beginning of his ministry by discharging the people from the burdensome tax called *acavale*, which had been continued on account of the war against Granada; and laboured with such zeal and success in the conversion of the Mahometans, that he made 3000 converts, among whom was a prince of the blood of the kings of Grenada. In 1509 Cardinal Ximenes extended the dominions of Ferdinand, by taking the city of Oran in the kingdom of Algiers. He undertook this conquest at his own expence, and marched in person at the head of the Spanish army clothed in his pontifical ornaments, and accompanied by a great number of ecclesiastics and monks. Some time after, foreseeing an extraordinary scarcity, he erected public granaries at Toledo, Alcala, and Torrelaguna, and had them filled with corn at his own expence; which gained the people's hearts to such a degree, that to preserve the memory of this noble action they had an eulogium upon it cut on marble, in the hall of the senate-house at Toledo, and in the market-place. King Ferdinand dying in 1516, left Cardinal Ximenes regent of his dominions; and the archduke Charles, who was afterwards the emperor Charles V. confirmed that nomination. The cardinal immediately made a reform of the officers of the supreme council and of the court, and put a stop to the oppression of the grandees. He vindicated the rights of the people against the nobility; and as by the feudal constitution the military power was lodged in the hands of the nobles, and men of inferior condition were called into the field only as their vassals, a king with scanty revenues depended on them in all his operations. From this state Ximenes resolved to deliver the crown; and issued a proclamation, commanding every city in Castile to inrol a certain number of its burgesses, and teach them military discipline; he himself engaging to provide officers to command them at the public expence. This was vigorously opposed by the nobles; but by his intrepidity and superior address he carried his point. He then endeavoured to diminish the possessions of the nobility, by reclaiming all the crown-lands, and putting a stop to the pensions granted by the late king Ferdinand. This addition made to the revenues enabled him to discharge all the debts of Ferdinand, and to establish magazines of warlike stores. The nobles, alarmed at these repeated attacks, uttered loud complaints; but before they proceeded to extremities, appointed some grandees of the first rank to examine the powers in consequence of which he exercised acts of such high authority. Ximenes received them with cold civility; produced the testament of Ferdinand, by which he was appointed regent, together with the ratification of that deed by Charles. To both these they objected; and he endeavoured to establish their validity. As the conversation grew warm, he led them insensibly to a balcony, from which they had a view of a large body of troops under arms, and of a formidable train of artillery. "Behold (says he, pointing to these, and raising his voice) the powers which I have received from his Catholic majesty: With these I govern Castile; and with these I will govern it, till the king, your master and mine, takes possession of his kingdom!" A declaration so bold and haughty silenced them, and astonished their associates. They saw that he was prepared for his defence, and laid aside all thoughts of a general confederacy against his administration. At length, from the repeated intreaties of Ximenes, and the impatient murmurs of the Spanish ministry, Charles V. embarked, and landed in Spain, accompanied by his favourites. Ximenes was advancing to the coast to meet him, but at Bos Equillos was seized with a violent disorder, which his followers considered as the effects of poison. This accident obliging Ximenes to stop, he wrote to the king, and with his usual boldness advised him to dismiss all the strangers in his train, whose number and credit already gave offence to the Spaniards, and earnestly desired to have an interview with him, that he might inform him of the state of the nation, and the temper of his subjects. To prevent this, not only the Flemings, but the Spanish grandees, employed all their address to keep Charles at a distance from Aranda, the place to which the cardinal had removed. His advice was now slighted and despised, Ximenes, conscious of his own integrity and merit, expected a more grateful return from a prince to whom he delivered a kingdom more flourishing than it had been in any former age, and a more extensive authority than the most illustrious of his ancestors had ever possessed; and lamented the fate of his country, about to be ruined by the rapaciousness and insolence of foreign favourites. While his mind was agitated by these passions, he received a letter from the king; in which, after a few

cold

cold and formal expressions of regard, he was allowed to retire to his diocese; and he expired a few hours after reading it in 1517, in the 81st year of his age.

This famous cardinal ought not to be confounded with *Roderic* XIMENES, archbishop of Toledo, in the 13th century, who wrote a History of Spain in nine books; nor with several other Spanish writers of the name of *Ximenes*.

XIPHIAS, the SWORD-FISH; a genus of fishes belonging to the order of *apodes*. See ICHTHYOLOGY *Index*. This fish is common in the Mediterranean sea, especially in that part which separates Italy from Sicily, and which has been long celebrated for it: the promontory Pelorus, now Capo di Faro, was a place noted for the resort of the xiphias, and possibly the station of the speculatores, or the persons who watched and gave notice of the approach of the fish.

The ancient method of taking them is particularly described by Strabo, and agrees exactly with that practised by the moderns. A man ascends one of the cliffs that overhangs the sea: as soon as he spies the fish, he gives notice, either by his voice or by signs, of the course it takes. Another that is stationed in a boat, climbs up the mast, and on seeing the sword-fish, directs the rowers towards it. As soon as he thinks they are got within reach, he descends, and taking a spear in his hand, strikes it into the fish; which, after wearying itself with its agitation, is seized and drawn into the boat. It is much esteemed by the Sicilians, who buy it up eagerly, and at its first coming into season give for it about sixpence English per pound. The season lasts from May till August. The ancients used to cut this fish into pieces and salt it; whence it was called *Tomus Thurianus*, from Thurii, a town in the bay of Tarentum, where it was taken and cured.

The sword-fish is said to be very voracious, and that it is a great enemy to the tunny, which (according to Belon) are as much terrified at it as sheep are at the sight of a wolf. It is a great enemy to whales, and frequently destroys them.

XYLO-ALOES, or ALOE WOOD, in the *Materia Medica*, is the product of a tree growing in China and some of the Indian islands. See EXCÆCARIA.

This drug is distinguished into three sorts; the calambac or tambac, the common lignum aloes, and calambour.

The calambac, or finest aloes wood, called by authors *lignum aloes prestantissimum*, and by the Chinese *suk-kiang*, is the most resinous of all the woods we are acquainted with: it is of a light spongy texture, very porous, and its pores so filled up with a soft and fragrant resin, that the whole may be pressed and dented by the fingers like wax, or moulded about by chewing in the mouth in the manner of mastich. This kind, laid on the fire, melts in great part like resin, and burns away in a few moments with a bright flame and perfumed smell. Its scent, while in the mass, is very fragrant and agreeable; and its taste acrid and bitterish, but very aromatic and agreeable. It is so variable in its colour, that some have divided it into three kinds; the one variegated with black and purple; the second, with the same black, but with yellowish instead of purple; and the third, yellow alone like the yolk of an egg: this last is the least scented of the three. The variation, however, is owing to the trunk of the tree being itself of three different colours; and the heart of it is the valuable sort first described. The two following are supposed to be the outer parts of the trunk; though this seems doubtful, especially in regard to the last sort, from the circumstance mentioned of its being found in large logs entire, and sometimes only the *heart*, which, as above noticed, constitutes the calambac.

The *lignum aloes vulgare* is the second in value. This is of a more dense and compact texture, and consequently less resinous than the other; there is some of it, however, that is spongy, and has the holes filled up with the right resinous matter; and all of it, when good, has veins of the same resin in it. We meet with it in small fragments, which have been cut and split from larger: these are of a tolerably dense texture in the more solid pieces, and of a dusky brown colour, variegated with resinous black veins. It is in this state very heavy, and less fragrant than in those pieces which show a multitude of little holes, filled up with the same blackish matter that forms the veins in others. The woody part of these last pieces is somewhat darker than the other, and is not unfrequently purplish, or even blackish. The smell of the common aloe wood is very agreeable, but not so strongly perfumed as the former. Its taste is somewhat bitter and acrid, but very aromatic.

The calambour, called also *agallochum sylvestre*, and *lignum aloes mexicanum*, is light and friable, of a dusky and often mottled colour, between a dusky green black and a deep brown. Its smell is fragrant and agreeable, but much less sweet than that of either of the others; and its taste bitterish, but not so much acrid or aromatic as either of the two former. This is said to be met with very frequently, and in large logs; and these sometimes entire, sometimes only the heart of the tree. This is the aloe wood used by the cabinet-makers and inlayers.

This drug is esteemed a cordial taken inwardly; and is sometimes given in disorders of the stomach and bowels, and to destroy the worms. A very fragrant oil may be procured from it by distillation; which is recommended in paralytic cases from five to fifteen drops. It is at present, however, but little used; and would scarce be met with anywhere in the shops, but that it is an ingredient in some of the old compositions.

XYNOECIA, in Grecian antiquity, an anniversary feast observed by the Athenians in honour of Minerva, upon the sixteenth of Hecatombæon, to commemorate their leaving, by the persuasion of Theseus, their country seats, in which they lay dispersed here and there in Attica, and uniting together in one body.

XYSTARCHA, in antiquity, the master or director of the xystus. In the Greek gymnasium the xystarcha was the second officer, and the gymnasiarcha the first; the former was his lieutenant, and presided over the two xysti, and all exercises of the athletæ therein.

XYSTUS, among the Greeks, was a long portico, open or covered at the top, where the athletæ practised wrestling and running: the gladiators, who practised therein, were called *xystici*. Among the Romans, the xystus was only an alley, or double row of trees, meeting like an arbour, and forming a shade to walk under.

Y.

Y
Yard.

Y, or y, the 23d letter of our alphabet: its sound is formed by expressing the breath with a sudden expansion of the lips from that configuration by which we express the vowel *u*. It is one of the ambigenial letters, being a consonant in the beginning of words, and placed before all vowels, as in *yard*, *yield*, *young*, &c. but before no consonant. At the end of words it is a vowel, and is substituted for the sound of *i*, as in *try*, *descry*, &c. In the middle of words it is not used so frequently as *i* is, unless in words derived from the Greek, as in *chyle*, *empyreal*, &c. though it is admitted into the middle of some pure English words, as in *dying*, *flying*, &c. The Romans had no capital of this letter, but used the small one in the middle and last syllables of words, as in *coryambus*, *onyx*, *martyr*. Y is also a numeral, signifying 150, or, according to Baronius, 159; and with a dash a-top, as Ȳ, it signified 150,000.

YACHT, or YATCH, a vessel of state, usually employed to convey princes, ambassadors, or other great personages, from one kingdom to another.

As the principal design of a yacht is to accommodate the passengers, it is usually fitted with a variety of convenient apartments, with suitable furniture, according to the quality or number of the persons contained therein.

The royal yachts are commonly rigged as ketches, except the principal one reserved for the sovereign, which is equipped with three masts like a ship. They are in general elegantly furnished, and richly ornamented with sculpture; and always commanded by captains in his majesty's navy.

Besides these, there are many other yachts of a smaller kind, employed by the commissioners of the excise, navy, and customs; or used as pleasure-boats by private gentlemen.

YAMS. See DIOSCOREA, } BOTANY *Index*.
YAMBOO. See EUGENIA, } BOTANY *Index*.

YARD *of a* SHIP, a long piece of timber suspended upon the masts of a ship, to extend the sails to the wind. See MAST and SAIL.

All yards are either square or lateen; the former of which are suspended across the masts at right angles, and the latter obliquely.

The square yards are nearly of a cylindrical surface. They taper from the middle, which is called the *slings*, towards the extremities, which are termed the *yard-arms*; and the distance between the slings and the yard-arms on each side is by the artificers divided into quarters, which are distinguished into the first, second, third quarters, and yard arms. The middle quarters are formed into eight squares, and each of the end parts is figured like the frustum of a cone. All the yards of a ship are square except that of the mizen.

The proportions for the length of yards, according to the different classes of ships in the British navy, are as follows:

			Guns.
1000 : gun-deck : :	560 :	main-yard, fig. 1.	100
	559 :	Pl. CCCCLXVIII.	90 80
	570 :	*Note*, the figure	70
	576 :	represents the	60
	575 :	yard and sails of	50
	561 :	a ship of 74 guns.	44
1000 : main-yard : :	880 :	fore-yard.	100 90 80
	874 :		all the rest.

To apply this rule to practice, suppose the gun-deck 144 feet. The proportion for this length is, as 1000 is to 575, so is 144 to 83; which will be the length of the main-yard in feet, and so of all the rest.

			Guns.
1000 : main-yard : :	820 :	mizen-yard	100 90 80 60 44
	847 :		70
	840 :		24
1000 : main-yard : :	726 :	main topsail-yard	24
	720 :		all the rest.
1000 : fore yard : :	719 :	fore topsail-yard	70
	726 :		24
	715 :		all the rest.
1000 : main topsail-yard : :		main top gallant yard	all the rates.
1000 fore topsail yard : :	696 :	fore top gallant-yard	70
	690 :		all the rest.
1000 : fore-topsail yard : :	768 :	mizen topsail-yard.	70
	750 :		all the rest.

Cross jack and sprit-sail yards equal to the fore topsail-yard.

Sprit-topsail-yard equal to the fore top-gallant-yard.

The diameters of yards are in the following proportions to their length.

The main and fore yards five-sevenths of an inch to one yard. The topsail, cross-jack, and sprit-sail yards, nine-fourteenths of an inch to one yard. The top-gallant, mizen topsail, and sprit-sail topsail yards, eight-thirteenths of an inch to one yard.

The mizen-yard five ninths of an inch to one yard.

All studding-sail booms and yards half an inch to one yard in length.

The lifts of the main-yard are exhibited in the above figure by *g g*; the horses and their stirrups by *h i*; the reef-tackles and their pendents by *k*, *l*; and the braces and brace-pendents by *m*, *n*.

The lateen-yards evidently derive their names from having been peculiar to the ancient Romans. They are usually composed of several pieces fastened together by wooldings, which also serve as steps whereby the sailors climb to the peek or upper extremity, in order to furl or cast loose the sail.

The mizen-yard of a ship, and the main-yard of a bilander, are hung obliquely on the mast, almost in the same manner as the lateen-yard of a xebec, settee, or polacre.

YARD, a measure of length used in Britain and Spain, consisting of three feet, chiefly to measure cloth, stuffs, &c.

Yar-

Yard-arm ‖ Yawning.

Yard-Arm is that half of the yard that is on either side of the mast, when it lies athwart the ship.

Yards also denotes places belonging to the navy, where the ships of war, &c. are laid up in harbour.—There are belonging to his majesty's navy six great yards, viz. Chatham, Deptford, Woolwich, Portsmouth, Sheerness, and Plymouth; these yards are fitted with several docks, wharfs, launches, and graving places, for the building, repairing, and cleaning of his majesty's ships; and therein are lodged great quantities of timber, masts, planks, anchors, and other materials: there are also convenient store-houses in each yard, in which are laid up vast quantities of cables, rigging, sails, blocks, and all other sorts of stores needful for the royal navy.

YARE, among sailors, implies ready or quick: as be yare at the helm; that is, be quick, ready, and expeditious at the helm. It is sometimes also used for bright by seamen: as, to keep his arms yare; that is, to keep them clean and bright.

Yare, a river of Norfolk, which runs from west to east through that county, passing by Norwich, and falling into the German sea at Yarmouth.

YARMOUTH, a sea-port town of Norfolk, with a market on Wednesdays and Saturdays, and a fair on Friday and Saturday in Easter-week for petty chapmen. It is seated on the river Yare, where it falls into the sea; and is a place of great strength, both by art and nature, being almost surrounded with water; and there is a drawbridge over the river. It is esteemed the key of this coast, and is a clean handsome place, whose houses are well built, it being a considerable town for trade. It has one large church, and a neat chapel, and the steeple of St Nicholas is so high that it serves for a sea-mark. It is governed by a mayor. The harbour is a very fine one, though it is very dangerous for strangers in windy weather; and it has for its security a pretty strong fort. The inhabitants in 1811 amounted to 17,977. It is 27 miles east of Norwich, and 112 north-east of London. E. Long. 1. 55. N. Lat. 52. 45.

Yarmouth, a town of the isle of Wight, in Hampshire, with a market on Fridays, and one fair on July 25th for toys. It is seated on the western part of the island, on the sea shore, and is encompassed with water; for, not many years ago a channel was cut through the peninsula, over which there is a drawbridge, and it is defended by a strong castle on the quay. It is a handsome place, whose houses are chiefly built with stone, and covered with slate; and it sends two members to parliament. The market is now disused. W. Long. 1. 28. N. Lat. 50. 40.

YARN, wool or flax spun into thread, of which they weave cloth. See Cloth.

YARROW. See Achillæa, Botany *Index*.

YAWNING, an involuntary opening of the mouth, generally produced by weariness or an inclination to sleep. Yawning, according to Boerhaave, is performed by expanding at one and the same time all the muscles capable of spontaneous motion; by greatly extending the lungs; by drawing in gradually and slowly a large quantity of air; and gradually and slowly breathing it out, after it has been retained for some time and rarefied; and then restoring the muscles to their natural state. Hence the effect of yawning is to move, accelerate, and equally distribute all the humours through all the vessels of the body, and consequently to qualify the muscles and organs of sensation for their various functions.

Yawning, Year.

Sanctorius observes, that a great deal is insensibly discharged, when nature endeavours to get rid of the retained perspirable matter, by yawning and stretching of the limbs. To these a person is most inclined just after sleep, because a greater quantity going off by the pores of the skin than at other times, whensoever a person wakes, the increasing contraction that then happens closes a great deal of the perspirable matter in the cutaneous passages, which will continually give such irritations as excite yawning and stretching; and such motions, by shaking the membranes of the whole body, and shifting the contact of their fibres, and the inclosed matter, by degrees throw it off. Hence we see the reason why healthful strong people are most inclined to such motions, because they perspire most in time of sleep, and therefore have more of the perspirable matter to lodge in the pores, and greater irritations thereunto. The advantages of some little exercise just after waking in a morning are considerable, as it throws off all the perspirable matter that is ready for its exit out of the body. When yawning is troublesome, Hippocrates says that long deep respiration or drawing in the air at long intervals cures it.

YEAR, in *Astronomy* and *Chronology*. See Astronomy and Kalendar.

The ancient Roman year was the lunar year, which, as first settled by Romulus, consisted of only 10 months; viz. 1. March, containing 31 days. 2. April, 30. 3. May, 31. 4. June, 30. 5. Quintilis, 31. 6. Sextilis, 30. 7. September, 30. 8. October 31. 9. November, 30. 10. December, 30.—In all 304 days; which came short of the true lunar year by 50 days, and of the solar by 61 days. Numa Pompilius corrected this irregular constitution of the year, and composed two new months, January and February, of the days that were used to be added to the former year.

The ancient Egyptian year, called also the *year of Nabonassar*, on account of the epoch of Nabonassar, is the solar year of 365 days, divided into 12 months, of 30 days each, besides five intercalary days added at the end. The names, &c. of the months are as follows: 1. Thoth. 2. Paophi. 3. Athyr. 4. Chojac. 5. Tybi. 6. Mecheir. 7. Phamenoth. 8. Pharmuthi. 9. Pachon. 10. Pauni. 11. Epiphi. 12. Mesori; beside the *ημεραι επαγομεναι*.

The ancient Greek year was lunar; consisting of 12 months, which at first had 30 days a-piece, then alternately 30 and 29 days, computed from the first appearance of the new moon; with the addition of an embolismic month of 30 days, every 3d, 5th, 8th, 11th, 14th, 16th, and 19th year of a cycle of 19 years; in order to keep the new and full moons to the same terms or seasons of the year. Their year commenced with that new moon, the full moon of which comes next after the summer solstice. The order, &c. of their months was thus: 1. Εκατομβαιων, containing 29 days. 2. Μεταγειτνιων, 30. 3. Βοηδρομιων, 29. 4. Μαιμακτηριων, 30. 5. Πυανεψιων, 29. 6. Ποσιδεων, 30. 7. Γαμηλιων, 29. 8. Ανθεστηριων, 30. 9. Ελαφηβολιων, 30. 10. Μουνυχιων, 30. 11. Θαργηλιων, 29. 12. Σκιροφοριων, 30.

The ancient Jewish year is a lunar year, consisting commonly

Year. commonly of 11 months, which alternately contain 30 and 29 days. It was made to agree with the solar year, either by the adding of 11, and sometimes 12 days, at the end of the year, or by an embolismic month. The names and quantities of the months stand thus: 1. Nisan, or Abib, 30 days. 2. Jiar, or Zius, 29. 3. Siban, or Siwan, 30. 4. Thammuz, or Tammuz, 29. 5. Ab, 30. 6. Elul, 29. 7. Tisri, or Ethanim, 30. 8. Marchesvam, or Bul, 29. 9. Cisleu, 30. 10. Tebeth, 29. 11. Sabat, or Schebeth, 30. 12. Adar, in the embolismic year, 30. Adar, in the common year, was but 29. Note, in the defective year, Cisleu was only 29 days; and in the redundant year, Marchesvam was 30.

The Persian year is a solar year of about 365 days; consisting of 12 months of 30 days each, with five intercalary days added at the end.

The Arabic, Mahometan, and Turkish year, called also the *year of the Hegira*, is a lunar year, equal to 354 days eight hours and 48 minutes, and consists of 12 months, which contain alternately 30 and 29 days.

The Hindoo year differs from all these, and is indeed different in different provinces of India. The best account that we have of it is by Mr Cavendish, in the Phil. Trans. of the Royal Society of London for the year 1792. "Before I speak of the civil year of the Hindoos (says this eminent philosopher), it will be proper to say a few words of the astronomical year, by which it is regulated.

"The astronomical year begins at the instant when the sun comes to the first point of the Hindoo zodiac. In the year 1792, it began on April 9th, at 22h. 14′ after midnight of their first meridian, which is about 41′ of time west of Calcutta; but, according to Mr Gentil's account of the Indian astronomy, it began 3h. 24′ earlier. As this year, however, is longer than ours, its commencement falls continually later, in respect of the Julian year, by 50′ 26″ in four years. This year is divided into 12 months, each of which corresponds to the time of the sun's stay in some sign; so that they are of different lengths, and seldom begin at the beginning of a day.

"The civil day in all parts of India begins at sunrise, and is divided into 60 parts called *dandas*, which are again divided into 60 palas. In those parts of India in which the Benares almanac, or as it is there called *patras*, is used, the civil year is lunisolar, consisting of 12 lunar months, with an intercalary month inserted between them occasionally. It begins at the day after the new moon next before the beginning of the solar year. The lunar month is divided into 30 parts called *teethees*; these are not strictly of the same length, but are equal to the time in which the moon's true motion from the sun is 12°. From the new moon till the moon arrives at 12° distance from the sun is called the first *teethee*; from thence till it comes to 24°, is called the second *teethee*; and so on till the full moon, after which the teethees return in the same order as before.

"The civil day is constantly called by the number of that teethee which expires during the course of the day; and as the teethee is sometimes longer than one day, a day sometimes occurs in which no teethee ends. When this is the case, the day is called by the same number as the following day; so that two successive days go by the same name. It oftener happens, however, that two teethees end on the same day; in which case the number of the first of them gives name to the day, and there is no day called by the number of the last, so that a gap is made in the order of the days. In the latter part of the month the days are counted from the full moon, in the same manner as in the former part they are counted from the new moon; only the last day, or that on which the new moon happens, is called the 30th, instead of the 15th. It appears, therefore, that each half of the month constantly begins on the day after that on which the new or full moon falls; only sometimes the half month begins with the second day, the first being wanting.

"This manner of counting the days is sufficiently intricate; but that of counting the months is still more so.

"The civil year, as was before said, begins at the day after the new moon; and, moreover, in the years which have an intercalary month, this month begins at the day after the new moon; but notwithstanding this, the ordinary civil month begins at the day after the full moon. To make their method more intelligible, we will call the time from new moon to new moon the natural month. The civil month Visākha, the first in the Hindoo kalender, which extends from the 9th of our April to the 10th of May, begins at the day after that full moon which is nearest to the instant at which the sun enters Mesha, the first in order of the Indian signs, whether before or after; however, it is not always accurately the nearest.

"A consequence of this way of counting the months is, that the first half of Chitra, the last month in the Indian kalender, extending from March the 10th to April the 9th, falls in one year, and the latter half in the following year; and whenever the sun enters no sign during a natural month, this month is intercalary. The number of days in the month varies from 29 to 32. Indeed the Hindoo months, both solar and lunar, consist neither of a determinate number of days, nor are regulated by any cycle, but depend solely on the motions of the sun and moon; so that a Hindoo has no way of knowing what day of the month it is but by consulting his almanac; and what is more, the month ought sometimes to begin on different days, in different places, on account of the difference in latitude and longitude, not to mention the difference which may arise from errors in computation. This mode of computing time must be attended with many inconveniences; but in the transactions of civil life the Hindoos do not much regard it. A disagreement, however, in the computation of the teethee, which sometimes also happens, occasions no small perplexity; because by the teethees or lunar days are regulated most of their religious festivals. Every Brahmin in charge of a temple, or whose duty it is to announce the times for the observance of religious ceremonies, is therefore furnished with one of their almanacs; and if he be an astronomer, he makes such corrections in it as the difference of latitude and longitude renders necessary."

New YEAR's Gift. See GIFT.

YEAST, or YEST, a head or scum rising upon beer or ale while working or fermenting in the vat. See BREWING.

It is used for a leaven or ferment in the baking of bread, as serving to swell or puff it up very considerably in

Yeast. in a little time, and to make it much lighter, softer, and more delicate. See BAKING, BARM, and BREAD.

Mr Henry has published a method of preparing *artificial yeast*, by which good bread may be made without the assistance of any other ferment. The method is this: Boil flour and water together to the consistence of treacle, and when the mixture is cold saturate it with fixed air. Pour the mixture thus saturated into one or more large bottles or narrow-mouthed jars; cover it over loosely with paper, and upon that lay a slate or board with a weight to keep it steady. Place the vessel in a situation where the thermometer will stand from 70° to 80°, and stir up the mixture two or three times in 24 hours. In about two days such a degree of fermentation will have taken place, as to give the mixture the appearance of yeast. With the yeast in this state, and before it has acquired a thoroughly vinous smell, mix the quantity of flour intended for bread, in the proportion of six pounds of flour to a quart of yeast, and a sufficient portion of warm water. Knead them well together in a proper vessel, and covering it with a cloth, let the dough stand for 12 hours, or till it appears to be sufficiently fermented in the fore-mentioned degree of warmth. It is then to be formed into loaves and baked. Mr Henry adds, that perhaps the yeast would be more perfect, if a decoction of malt were used instead of simple water.

It has lately been discovered, that a decoction of malt alone, without any addition, will produce a yeast proper enough for the purpose of brewing. This discovery was made by Joseph Senyor, servant of the reverend Mr Mason of Aston near Rotheram; and he received for it a reward of 20l. from the Society for promoting Arts, Manufactures, and Commerce. The process is as follows: Procure three earthen or wooden vessels of different sizes and apertures, one capable of holding two quarts, the other three or four, and the third five or six: boil a quarter of a peck of malt for about eight or ten minutes in three pints of water; and when a quart is poured off from the grains, let it stand in the first or smaller vessel in a cool place till not quite cold, but retaining that degree of heat which the brewers usually find to be proper when they begin to work their liquor. Then remove the vessel into some warm situation near a fire, where the thermometer stands between 70 and 80 degrees Fahrenheit, and there let it remain till the fermentation begins, which will be plainly perceived within 30 hours: add then two quarts more of a like decoction of malt, when cool, as the first was; and mix the whole in the second or larger vessel, and stir it well in, which must be repeated in the usual way, as it rises in a common vat: then add a still greater quantity of the same decoction, to be worked in the largest vessel, which will produce yeast enough for a brewing of 40 gallons.

Common ale yeast may be kept fresh and fit for use several months by the following method: Put a quantity of it into a close canvas bag, and gently squeeze out the moisture in a screw-press till the remaining matter be as firm and stiff as clay. In this state it may be close packed up in a tight cask for securing it from the air; and will keep fresh, sound, and fit for use, for a long time. This is a secret that might be of great use to the brewers and distillers, who, though they employ very large quantities of yeast, seem to know no method of preserving it, or raising nurseries of it; for want of which they sustain a very considerable loss; whereas the brewers in Flanders make a very great advantage of supplying the malt distillers of Holland with yeast, which is rendered lasting and fit for carriage by this easy expedient.

Yell ‖ Yew.

YELL, one of the islands of Shetland, lying north-east from the Mainland, and divided from it by an arm of the sea, called *Yell-Sound*. By some it is thought to have been the *Thule* of the ancients. In the old descriptions it is said to be 20 miles long and 8 broad. It is very mountainous and full of moss; but there are pretty considerable pastures in which they feed a great many sheep; and it also affords plenty of peat. It has eight large harbours, which would not be thought despicable in other countries. Anciently it seems to have been pretty populous, since there are in it three churches, twenty chapels, and many brughs or Pictish forts.

YELLOW, one of the original colours of light.

YELLOW-Colour for House-painting. See COLOUR-*Making*.

Naples YELLOW, a beautiful colour much used by painters, formerly thought to be prepared from arsenic, but now discovered to have lead for its basis.

YELLOW-Hammer. See FRINGILLA, ORNITHOLOGY *Index*.

YELLOW-Fever. See MEDICINE, N° 168.

YEMEN, a province of Arabia, stretching along the Red sea and Indian ocean, and forming a part of the country once known by the name of Arabia Felix.

YEOMAN, the first or highest degree among the plebeians of England, next in order to the gentry.

The yeomen are properly freeholders, who having land of their own, live on good husbandry.

YEOMAN is also a title of office in the king's household, of a middle place or rank between an officer and a groom.

YEOMEN of the Guard were anciently 250 men of the best rank under gentry, and of larger stature than ordinary, each being required to be six feet high. At present there are but 100 yeomen in constant duty, and 70 more not in duty; and as any of the 100 dies, his place is supplied out of the 70. They go dressed after the manner of King Henry VIII.'s time. They formerly had diet as well as wages when in waiting; but this was taken off in the reign of Queen Anne.

YEST, or YEAST. See YEAST.

YEW. See TAXUS, BOTANY *Index*.

Yew trees are remarkable for their duration. There are now growing within 300 yards of the old Gothic ruins of Fountain's abbey, near Rippon, in Yorkshire, seven very large yew trees, commonly called the Seven Sisters, whose exact ages cannot be accurately ascertained, though tradition says that they were standing in the year 1088. It is said also, that when the great Fountain's abbey was building, which is 700 feet long, and was finished in 1283, the masons used to work their stones, during the hot summers, under the shade of these trees. The circumference of the Seven Sisters, when measured by a curious traveller, were of the following sizes:—the smallest tree, round its body, 5 yards 1 foot; fours others are from $5\frac{1}{2}$ to $7\frac{1}{2}$ yards; the sixth is $9\frac{2}{3}$ yards; and the seventh is 11 yards 1 foot 7 inches in circumference, being 2 yards 10 inches larger than the great

Yew & York.

great yew tree now growing in the churchyard at Gresford, in North Wales, which is 9 yards 9 inches. These trees are the largest and oldest in the British dominions.

YNCA, an appellation anciently given to the kings of Peru, and the princes of their blood; the word literally signifying lord, king, emperor, and royal blood.

YOAK, or YOKE, in *Agriculture*, a frame of wood fitted over the necks of oxen, whereby they are coupled together and harnessed to the plough.

Yoak of Land, anciently was the space which a yoke of oxen, that is, two oxen, may plough in one day.

YOLK, the yellow part in the middle of an egg (see EGG).

YONNE, a department in the central part of France, lying along both sides of the river Yonne. The soil is fertile, and produces grain of all kinds, hemp, legumes, fruits, and vines. Wine is a principal article of commerce in this department. Wood and pasturage also abound. The manufactures, which consist of woollens, cottons, hosiery, leather, paper, glass, ironwork, &c. are not of great importance. The extent of this department is 729,226 hectares, and the population in 1817 amounted to 325,994. Auxerre is the chief town.

YORK, in Latin *Eboracum*, the capital of Yorkshire in England. This city is so ancient that the origin of it is uncertain. In the time of the Romans a legion was stationed here, it being then the capital of the Brigantes; and here died the emperor Severus, and Flavius Valerius Constantius Chlorus, father of Constantine the Great. There was then also a temple of Bellona here, and no less than three military ways went from hence. In the time of the Saxons it was erected into an archbishopric by Pope Honorius, to which are now subject the bishoprics of Chester, Durham, Carlisle, and the isle of Man; though anciently 12 bishoprics in England, and all Scotland, were. A horn is still kept in the minster, by which Ulphius, one of the Saxon princes, bestowed all his lands and revenues upon the church.

This city suffered very much during the ravages of the Danes; but, after the Conquest, it began to flourish again. The cathedral, which cost a long time and a great deal of money in building, is a most stately Gothic pile. Its chapter-house is particularly admired for its painted glass, its fine marble stalls, its pillars of alabaster, and curious contrivance. In it is the following line in gold letters:

Ut Rosa, flos florum, sic est Domus ista Domorum.

The choir is remarkable for its fine carvings, particularly the statues of all the English monarchs; and the windows are exquisitely painted with the history of the Bible. The lanthorn steeple is 70 feet square, and 188 high, and the windows are 45. At the south end is a circular light, called the *marigold window* from the colour of its glass; and at the north end is a very large one, whose painting represents embroidery.

This city was formerly reckoned the second city in England; but though it stands upon more ground, it is inferior in trade, wealth, and population, to Manchester, Liverpool, and several other cities. The inhabitants amounted to 18,217 in 1811. It is situated in a fine plain, on both sides the Ouse, walled and divided into four wards, containing 28 parishes. It enjoys large privileges and immunities, conferred upon it by a succession of kings from Henry II. and its chief magistrate has the title of *lord mayor*, which is an honour peculiar to it and London. Richard II. made it a county of itself. The conservancy of most of the rivers of the county, within certain limits, belongs to the lord mayor and aldermen. The middle arch of the bridge here over the Ouse is thought to equal the Rialto at Venice in architecture, height, and breadth, the diameter being 81 feet, and the height 51. Though this city is 60 miles distant from the sea, yet ships of 70 tons burden come up the river to it. The town-house or guild-hall stands upon the bridge, and is superior in all respects to that of London. In the Popish times there were nine abbeys here, and a vast number of churches; but of the latter there are only 17 now. The steeple of that of Allhallows is reckoned the finest in England. The archbishop has a fine palace; and the assembly-room, designed by the earl of Burlington, is very noble. Here are plays, assemblies, concerts, and the like entertainments, at some house or other, almost every night in the week. In the old castle, built originally by William the Conqueror, and repaired in 1701, the assizes are kept. It serves also for the county-gaol, which is the neatest and pleasantest in England, with an area larger than that of the king's-bench, and it has a handsome chapel in it, with a good allowance for a preacher. This city has long given the title of *duke* to some branch of the royal family,

Yo... York.

The plenty and cheapness of provisions induces many persons of small fortune, or that would live frugally, to take up their abode here; and the venerable remains of Roman antiquities, and those of a later date, as abbeys, churches, and castles, procure this city a visit from every curious traveller. Many Roman altars, urns, coins, inscriptions, &c. have been found; and Saxon coins are still extant that have been struck here. The members, being two in number, for this city, have precedence of all others, except those of London, in the house of commons. An infirmary, after the manner of those of Bath, Bristol, &c. hath been erected in it; and a cotton manufacture established and brought to great perfection. Besides four weekly markets, it has a great many fairs; one, in particular, every other Thursday for cattle and sheep. W. Long. 1. 1. N. Lat. 53. 59.

YORKSHIRE, the largest county of England, bounded on the south by Derbyshire, Nottinghamshire, and Lincolnshire; on the north by Durham and Westmoreland; on the east by the German ocean; and on the west by Lancashire and a part of Cheshire.—It is upwards of 80 miles in length from east to west, nearly as much in breadth, and about 360 in circumference, containing, in the whole, 26 hundreds or wapentakes, 49 market-towns, 563 parishes, 242 vicarages, with many chapels of ease, and 2330 villages. Its area is computed by some at 4684 square miles, and its inhabitants in 1811 amounted to 973,113, of whom 305,150 lived in towns, and 667,963 in the country. It is divided into three parts or ridings, viz. the West, East, and North; so denominated from their situation, in respect of the city of York. Each of these is as large, if not larger, than any ordinary county. There are other divisions, as Richmondshire, Allertonshire, Howdenshire, Hallanshire, Craven, Cleveland, Marshland, Holderness, &c.

As the soil and face of the country vary greatly, so does

York. does the air. In the hilly parts the air is good, but the soil very indifferent; of the lower some are marshy, others drier, and the soil of both rich; but the air of the former is more foggy and unhealthy than that of the latter. The manufactures of this county are cutlery and hard-wares, particularly knives, bits, and spurs; but the principal are stockings and woollen cloth, with which it supplies in a great measure Germany and the North. As to the produce, it abounds in corn, cattle, horses, lead and iron, coal, wood, lime, liquorice, alum, jet, &c. It lies wholly in the northern circuit, and much the greater part of it in the diocese of York; that only which is called *Richmondshire* belonging to the diocese of Chester. The members it sends to parliament are 30; of which two are for the shire and 28 for the towns.

New-York, one of the United States of America, is bounded towards the south-east by the Atlantic ocean; east by Connecticut, Massachusets, and Vermont; north by the 45th degree of latitude, which divides it from Canada; north-westwardly by the river Iroquois or St Lawrence, and the lakes Ontario and Erie; south-west and south by Pennsylvania and New Jersey. The whose state contains about 44,000 square miles, equal to 28,160,000 acres.

The state, to speak generally, abounds with lakes, some of salt and others of fresh water. It is intersected by ridges of mountains running in a north-east and south-west direction. Beyond the Allegany mountains, however, the country is a dead level, of a fine rich soil, covered in its natural state, with maple, beech, birch, cherry, black-walnut, locust, hickory, and some mulberry trees. On the banks of Lake Erie, are a few chesnut and oak ridges. Hemlock swamps are interspersed thinly through the country. All the creeks that empty into Lake Erie have falls, which afford many excellent mill seats. East of the Allegany mountains, the country is broken into hills with rich intervening valleys. The hills are clothed thick with timber, and when cleared afford fine pasture; the valleys, when cultivated, produce wheat, hemp, flax, pease, grass, oats, Indian corn.

The principal rivers are the Hudson, and the Mohawk, which is a branch of the former. The Hudson is navigable for sloops 160 miles from its mouth, and by the Mohawk boats ascend about 70 miles farther. A canal is now in progress to extend the inland navigation from the head waters of the Mohawk to Lake Erie, a distance of 200 miles. In the north eastern ports, Lake Champlain affords a navigable communication for 100 miles; and the St Lawrence, with lakes Ontario and Erie, for many hundred miles more, on the north-western frontier.

Iron abounds in the state of New York, and lead is wrought at some places, but the other metals are scarce. Roofing slate, lime-stone, marble, and coal are found in some situations. Gypsum and salt (from springs) are abundant in the western parts. The mineral waters of Balston and Saratoga are celebrated for their medicinal virtues.

The wild animals are now becoming rare in this state. The wolf, formerly common, is seldom seen. The bears, which are still found in considerable numbers, often carry off the hogs from new settlements. The cougouar seldom appears; the deer, fox, marten, beaver, and squirrel are found occasionally. Snakes of a large size are met with in the uncultivated parts. York.

The population of this state in 1749 was estimated at 100,000; in 1800 it amounted to 586,050; and in 1810, to 959,049, including 15,017 slaves. At the last mentioned period New York was the second state in the union for population; but it is probably now the first.

The legislative power is vested in a senate and house of assembly. The latter is elected annually by ballot, by electors who must be freeholders to the value of fifty dollars, or residents renting tenements of five dollars yearly value. The senate is elected for four years, one fourth being renewed every year. The permanent number of senators is 32, of members of the lower house 150. The executive power resides in a governor elected for three years by the freeholders, with a council of four senators, chosen annually by the legislature. The judges, who are appointed by the governor and council, hold their offices during good behaviour till the age of sixty.

There is no state religion, but the clergymen of each persuasion are supported by the voluntary contributions of their congregations. The Presbyterians are the most numerous sect, the Episcopalians next. The Baptists, Methodists, Quakers, and Roman Catholics are also pretty numerous. In 1815, there were 2621 primary schools in the state, at which 140,720 scholars were educated. It is rare to meet with any person in this state who cannot read and write. There is also a considerable number of academies, and three colleges,—Columbia College founded in 1754, Union College founded in 1794; and Hamilton College in 1812. The number of scientific and humane societies is also considerable. Above seventy newspapers are printed in the state.

The manufactures of this state consist of iron, glass, gunpowder, woollens, linens and cottons, cordage, spirits, leather, hats, &c. Though several large works are established, about one third of the articles produced are made in families. The whole value of manufactures in 1810 was thirty-three millions of dollars; but during the war with England in 1814, the amount was supposed not to fall short of fifty millions. So rapid has been the accumulation of capital in this state, that the value of lands and houses, which was found by a fiscal survey in 1799 to be 100,380,706 dollars, amounted according to a new survey in 1814 to 269,370,900 dollars. The exports of this state, in 1817, amounted to 18,707,433 dollars; being one half greater than those of any other state in the union.

Though New York is the first commercial state in North America, the bulk of the inhabitants live by agriculture. They are generally industrious, sober, and well informed. There are still some small societies of Dutch and Germans, who preserve both the language and manners of their country. In general the inhabitants of this state are neither infected with the hypocritical austerity, pride, and selfishness of the New Englanders, nor with the lax morality and ostentatious habits of the people of the southern states. In times of difficulty they have generally held a moderate course.

New-York, a city of North America, capital of the state of the same name. It is situated at the south-west point.

York. point of an island, at the confluence of Hudson and East rivers, and is about four miles in circumference. The situation is both healthy and pleasant. Surrounded on all sides by water, it is refreshed by cool breezes in summer, and the air in winter is more temperate than in other places under the same parallel. York island is 15 miles in length, and hardly one in breadth. It is joined to the main by a bridge called King's bridge. The channels between Long and Staten islands, and between Long and York islands, are so narrow as to occasion an unusual rapidity of the tides, which is increased by the confluence of the waters of Hudson and East rivers. This rapidity, in general, prevents the obstruction of the channel by ice. There is no bason or bay for the reception of ships; but the road where they lie in East river is defended from the violence of the sea by the islands which interlock with each other; so that, except that of Rhode island, the harbour of New-York, which admits ships of any burden, is the best of the United States. The number of the inhabitants in 1817 was estimated at 120,000.

The most magnificent edifice in this city is *Federal Hall*, at the head of Broadstreet; in a gallery in front of which General Washington, attended by the senate and house of representatives, took his oath of office at the commencement of the operation of the federal constitution, 30th April, 1789. Near this building is another, appropriated to the American Museum and Academy of Fine Arts. There were about fifty churches and meeting-houses in the city in 1817, many of which are built and fitted up in a style of great elegance, and even splendour. The best private houses are built of brick painted red, and have a very neat and cleanly appearance. There is a theatre of great size, though not a fine building. The battery, which fronts the sea, forms one of the most beautiful walks of which any city can boast. Several of the principal streets being garnished with rows of trees, have an uncommonly gay and pleasing effect. In New York, as in many old towns in Britain, the entries to cellars project into the street, and injure both the beauty and the conveniency of the foot pavement. The street is also encumbered by large quantities of goods piled up at the outside of the shop doors; and great numbers of pigs are seen running about. Formerly the city suffered much from the want of water, but now it is conveyed in pipes to all the streets in abundance. Rents are high, even when a comparison is made with London. The natural harbour of New York is one of the best in America, and its trade is so great, that it amounts to nearly one-fifth of the whole foreign trade of the United States. It is probably at present the second trading city in Europe or America.

King's college was chiefly founded by the voluntary contributions of the inhabitants of the province, assisted by the general assembly, and the corporation of Trinity Church, and in the year 1754, obtained a royal charter. The building consists of an elegant stone edifice, three stories high, with four stair cases, 12 apartments in each, a chapel, hall, library, museum, anatomical theatre, and a school for experimental philosophy. It is situated on a dry gravelly soil, about 150 yards from the bank of Hudson's river, commanding a beautiful and extensive prospect. Since the revolution, the legislature passed an act constituting 21 gentlemen (of whom the governor and lieutenant-governor for the time being, are members *ex officiis*) a body corporate and politic by the name of "The Regents of the University of the State of New-York." They are entrusted with the care of literature in general, and have power to grant charters for erecting colleges and academies through the state. It is now denominated *Columbia college*. It consists of a faculty of arts, and one of physic, the first having a president and seven professors, and the second a dean, and the same number of professors.

The government of this city is at present in the hands of a mayor, aldermen, and common council; and the city is divided into seven wards, in each of which an alderman and assistant are annually chosen by the people. A court of session is held for the trial of criminal causes. There were eight banks in the city in 1814; and there is a great number of literary, scientific, and benevolent institutions. The shipping belonging to the port in 1815 amounted to 278,868 tons. New-York is 95 miles N. E. of Philadelphia, 197 N. E. of Baltimore, and 913 from Charleston. W. Long. 74° 9′ 45″. N. Lat. 40° 42′ 8″.

YOUNG, DR EDWARD, was the son of a clergyman of the same name, and was born about the year 1679. When sufficiently qualified, he was matriculated into All-Souls college, Oxford; and designing to follow the civil law, he took a degree in that profession. In this situation he wrote his poem called The Last Day, published in 1704; which coming from a layman gave universal satisfaction: this was soon after followed by another, entitled The Force of Religion, or Vanquished Love. These productions gained him a respectable acquaintance; he was intimate with Addison, and thus became one of the writers of the Spectator: but the turn of his mind leading him to the church, he took orders, was made one of the king's chaplains, and obtained the living of Welwyn in Hertfordshire, worth about 500l. per annum, but he never rose to higher preferment. For some years before the death of the late prince of Wales, Dr Young attended his court pretty constantly; but upon his decease all his hopes of church preferment vanished; however, upon the death of Dr Hales, he was taken into the service of the princess dowager of Wales, and succeeded him as her privy chaplain. When pretty far advanced in life, he married the lady Elizabeth Lee, daughter of the late earl of Litchfield. This lady was a widow, and had an amiable son and daughter, who both died young. What he felt for their loss, as well as for that of his wife, is finely expressed in his Night Thoughts, in which the young lady is characterised under the name of Narcissa; her brother by that of Philander; and his wife, though nameless, is frequently mentioned; and he thus, in an apostrophe to death, deplores the loss of all the three.

> Insatiate archer, could not once suffice!
> Thy shaft flew thrice, and thrice my peace was slain,
> And thrice ere thrice yon moon renew'd her horn.

He wrote three tragedies, The Revenge, Busiris, and The Brothers. His satires, called Love of Fame the universal Passion, are by many esteemed his principal performance; though Swift said the poet should have been

Young. been either more angry or more merry: they have been characterised as a string of epigrams written on one subject, that tire the reader before he gets through them. His Complaint, or Night Thoughts, exhibit him as a moral and melancholy poet, and are esteemed his masterpiece. They form a species of poetry peculiarly his own, and in which he has been unrivalled by all those who attempted to write in this manner. They were written under the recent pressure of his sorrow for the loss of his wife, daughter, and son-in-law; they are addressed to Lorenzo, a man of pleasure and the world, and who, as it is insinuated by some, is his own son, but then labouring under his father's displeasure. As a prose-writer, he arraigned the prevailing manners of his time, in a work called The Centaur not Fabulous; and when he was above 80 years of age, published Conjectures on Original Composition. He published some other pieces; and the whole of his works are collected in 4 and 5 vols 12mo. Dr Young's turn of mind was naturally solemn; and he usually, when at home in the country, spent many hours of the day walking in his own church-yard among the tombs. His conversation, his writings, had all a reference to the life after this; and this turn of disposition mixed itself even with his improvements in gardening. He had, for instance, an alcove with a bench, so painted, near his house, that at a distance it looked as a real one which the spectator was then approaching. Upon coming up near it, however, the deception was perceived, and this motto appeared, *Invisibilia non decipiunt*, "The things unseen do not deceive us." Yet, notwithstanding this gloominess of temper, he was fond of innocent sports and amusement: he instituted an assembly and a bowling-green in the parish of which he was rector, and often promoted the gaiety of the company in person. His wit was generally poignant, and ever levelled at those who testified any contempt for decency and religion. His epigram, spoken extempore on Voltaire, is well known; who happening in his company to ridicule Milton, and the allegorical personages of Death and Sin, Young thus addressed him:

Thou art so witty, profligate, and thin,
You seem a Milton with his Death and Sin.

Young ‖ Yunx. One Sunday, preaching in office at St James's, he found, that though he strove to make his audience attentive, he could not prevail. Upon which his pity for their folly got the better of all decorums, and he sat back in the pulpit and burst into a flood of tears. Towards the latter part of life he knew his own infirmities, and suffered himself to be in pupilage to his house-keeper; for he considered that, at a certain time of life, the second childhood of age demanded its wonted protection. His son, whose boyish follies were long obnoxious to paternal severity, was at last forgiven in his will; and our poet died regretted by all, having performed all that man could do to fill his post with dignity. His death happened in 1765.

YOUTH, that state of man in which he approaches towards his greatest perfection of body.

YPRES, a handsome, large, and populous town of the kingdom of the Netherlands, with a bishop's see. It has a considerable manufactory in cloth and serges, and every year in Lent there is a considerable fair. It is one of the barrier towns, but was besieged and taken by the French in 1744, and also in 1794. It is seated in a fertile plain on the river Ypre, in E. Long. 2. 48. N. Lat. 50. 51.

YTTRIA, one of the lately discovered earths. For an account of its properties and combinations, see CHEMISTRY, N° 1457.

Yttrio-Tantalite, a mineral substance containing the new earth yttria, and the new metal tantalium, which latter is found by Dr Wollaston to be identical with columbium.

YUCCA, ADAM'S NEEDLE, a genus of plants of the class hexandria. The species of this plant are all exceedingly curious in their growth, and are therefore much cultivated in gardens. The Indians make a kind of bread from the roots of this plant.

YULE, YOOL, or *Iul*. See IUL.

YUNX, a genus of birds of the order *picæ*. See ORNITHOLOGY *Index*.

Z.

Z. Z, or z, the 24th and last letter, and the 19th consonant of our alphabet; the sound of which is formed by a motion of the tongue from the palate downwards and upwards to it again, with a shutting and opening of the teeth at the same time. This letter has been reputed a double consonant, having the sound *ds*; but some think with very little reason: and, as if we thought otherwise, we often double it, as in *puzzle*, *muzzle*, &c. Among the ancients, Z was a numeral letter, signifying 2000; and with a dash added a-top, $\bar{Z}$ signified 2000 times 2000, or 4,000,000.

In abbreviations this letter formerly stood as a mark for several sorts of weights; sometimes it signified an ounce and a half; and very frequently it stood for half an ounce; sometimes for the eighth part of an ounce, or a dram troy weight; and it has in earlier times been used to express the third part of an ounce or eight scruples. ZZ were used by some of the ancient physicians to express myrrh, and at present they are often used to signify zinziber or ginger.

Z, Zaara. ZAARA, ZAPARA, SAHARA, or *the Desert*, a vast country of Africa, bounded on the north by Barbary, on the east by Fezzan and Cashna, on the south by Tombuctoo, and on the west by the Atlantic ocean. Zaara contains a variety of wandering nations, all proceeding from Arabs, Moors, and fugitive Portuguese, who took refuge there when the family of the Sherifs made themselves masters of the three kingdoms of Barbary.

bary. All these people bear indiscriminately the names of *Nars*, *Moors*, or *Arabs*. They are subdivided into various nations, of which the most considerable are the Mongearts, Trasars, and Bracnars. The Mongearts lead a wandering life, and live chiefly on the milk of their flocks, with a little barley-meal, and some dates. The poorer sort go naked, except the females, who commonly wrap a clout about their middle, and wear a kind of bonnet on their head; but the wealthier sort have a kind of loose gown, made of blue calico, with large sleeves, that is brought them from Negroland. When they move from one place to another for fresh pasture, water, or prey, most of them ride on camels, which have generally a sort of saddle between the bunch and the neck, with a string or strap run through their nostrils, which serves for a bridle; and instead of spurs they use a sharp bodkin. Their tents or huts are covered with a coarse stuff, made of camel's hair, and a kind of wool or moss that grows on the palm trees. These Arabs live here under the government of their sheiks or cheyks; as in Arabia, Egypt, and other places. The other two tribes are rather more civilized. They are all Mahometans.

ZABULON, in *Ancient Geography*, one of the twelve tribes; bounded on the north by the tribes of Asher and Naphthali; on the east by the sea of Galilee; on the south by the tribe of Issachar or the brook Cison, which ran between both; on the west by the Mediterranean; so that it touched two seas, or was bimarous.

ZABULON, in *Ancient Geography*, a very strong town in the tribe of that name, on the Mediterranean, sirnamed *of men*, near Ptolemais: its vicinity to which makes it probable that it was also Chabulon, unless either name is a faulty reading in Josephus; distant about 60 stadia from Ptolemais.

ZACYNTHUS, in *Ancient Geography*, an island to the south of Cephalenia 60 stadia, but nearer to Peloponnesus, in the Ionian sea, formerly subject to Ulysses, in compass above 160 stadia, woody and fruitful, with a considerable cognominal town and a port. The island lies over against Elis, having a colony of Achæans from Peloponnesus, over against the Corinthian gulf. Both island and town are now called *Zante*.

ZAFFRE, is the oxide of cobalt, employed for painting pottery ware and porcelain of a blue colour. The method of preparing it is as follows: The cobalt taken out of the mine is broken with hammers into pieces about the size of a hen's egg; and the stony involucrum, with such other heterogeneous matters as are distinguishable by the eye, are separated as much as possible. The chosen mineral is then pounded in stamping mills, and sifted through brass wire sieves. The lighter parts are washed off by water, and it is afterwards put into a large flat-bottomed arched furnace, resembling a baking oven, where the flame of the wood reverberates upon the ore; which is occasionally stirred and turned with long handled iron hooks or rakes; and the process is continued till it ceases to emit any fumes. The oven or furnace is terminated by a long horizontal gallery, which serves for a chimney; in which the arsenic, naturally mixed with the ore, sublimes. If the ore contains a little bismuth, as this semimetal is very fusible, it is collected at the bottom of the furnace. The cobalt remains in the state of a dark gray oxide, and is called *zaffre*. One hundred pounds of the cobalt ore lose 20 and even 30 per cent. during this operation, which is continued 4 or even 9 hours, according to the quality of the ore. The roasted ore being taken out from the furnace, such parts as are concreted into lumps are pounded and sifted afresh. Zaffre, in commerce, is never pure, being mixed with two or rather three parts of powdered flints. A proper quantity of the best sort of these, after being ignited in a furnace, is thrown into water to render it friable, and more easily reduced to powder; which, being sifted, is mixed with the zaffre, according to the before-mentioned dose; and the mixture is put into casks, after being moistened with water. This oxide, fused with three parts of sand and one of potash, forms a blue glass; which, when pounded, sifted, and afterwards ground in mills, included in large casks, forms *smalt*.

The blue of zaffre is the most solid and fixed of all the colours that can be employed in vitrification. It suffers no change from the most violent fire. It is successfully employed to give shades of blue to enamels, and to the crystal glasses made in imitation of some opaque and transparent precious stones, as the lapis lazuli, the turquois, the sapphire, and others of this kind.

ZALEUCUS, a famous legislator of the Locrians, and the disciple of Pythagoras, flourished 500 years, B. C. He made a law, by which he punished adulterers with the loss of both their eyes; and his son offending, was not absolved from this punishment: yet, to show the father as well as the just lawgiver, he put out his own right, and his son's left eye. This example of justice and severity made so strong an impression on the minds of his subjects, that no instance was found of the commission of that vice during the reign of that legislator. It is added, that Zaleucus forbade any wine being given to the sick on pain of death, unless it was prescribed by the physicians; and that he was so jealous of his laws, that he ordered, that whoever was desirous of changing them, should be obliged, when he made the proposal, to have a cord about his neck, in order that he might be immediately strangled, if those alterations were esteemed no better than the laws already established. Diodorus Siculus attributes the same thing to Charondas legislator of the Sybarites.

ZAMA, in *Ancient Geography*, a town of Chamane, a district of Cappadocia, of unknown situation.—Another Zama, of Mesopotamia, on the Saocoras, to the south of Nisibis.—A third, of Numidia, distant five days journey to the west of Carthage: it was the other royal residence of the kings of Numidia, hence called *Zama Regia*. It stood in a plain; was stronger by art than nature; richly supplied with every necessary; and abounding in men, and every weapon both of defence and annoyance.

The last of these is remarkable for the decisive battle fought betwen the two greatest commanders in the world, Hannibal the Carthaginian and Scipio Africanus. Of this engagement, the most important perhaps that ever was fought, Mr Hooke gives the following account.

"Scipio drew up his army after the Roman manner, except that he placed the cohorts of the Principes directly behind those of the Hastati, so as to leave sufficient space for the enemy's elephants to pass through from

Zama.

from front to rear. C. Lælius was posted on the left wing with the Italian horse, and Masinissa with his Numidians on the right. The intervals of the first line Scipio filled up with his Velites, or light-armed troops, ordering them, upon a signal given, to begin the battle; and, in case they were repulsed, or broke by the elephants, to run back through the lanes before mentioned, and continue on their flight till they were got behind the Triarii. Those that were wounded, or in danger of being overtaken, were to turn off to the right and left through the spaces between the lines, and that way escape to the rear.

"The army thus drawn up, Scipio went from rank to rank, urging his soldiers to consider the consequences of a defeat and the rewards of victory: on the one hand, certain death or slavery (for they had no town in Africa strong enough to protect them); on the other, not only a lasting superiority over Carthage, but the empire of the rest of the world.

"Hannibal ranged all his elephants, to the number of above 80, in one front. Behind these he placed his mercenaries, consisting of 12,000 men, Ligurians, Gauls, Baleares, and Mauritanians.

"The new levies of Carthaginians and other Africans, together with 4000 Macedonians, under a general named *Sopater*, composed the second line. And in the rear of all, at the distance of about a furlong, he posted his Italian troops, in whom he chiefly confided. The Carthaginian horse formed his right wing, the Numidians his left.

"He ordered their several leaders to exhort their troops not to be discouraged by their own weakness, but to place the hope of victory in him and his Italian army; and particularly directed the captains of the Carthaginians to represent to them what would be the fate of their wives and children if the event of this battle should not prove successful. The general himself, walking through the ranks of his Italian troops, called upon them to be mindful of the 17 campaigns in which they had been fellow-soldiers with him; and of that constant series of victories by which they had extinguished in the Romans all hope of ever being conquerors. He urged them to remember, above all, the battles of Trebia, Thrasymenus, and Cannæ; with any of which the approaching battle was in no wise to be compared, either with respect to the bravery or the number of the enemy. 'The Romans were yet unfoiled, and in the height of their strength, when you first met them in the field; nevertheless you vanquished them. The soldiers now before us are either the children of the vanquished, or the remains of those whom you have often put to flight in Italy. Maintain therefore your general's glory and your own, and establish to yourselves the name of invincible, by which you are become famous throughout the world.'

"When the Numidians of the two armies had skirmished a while, Hannibal ordered the managers of the elephants to drive them upon the enemy. Some of the beasts, frightened at the noise of the trumpets and other instruments of war which sounded on all sides, immediately ran back amongst the Numidians of the Carthaginian left wing, and put them into confusion; which Masinissa taking advantage of, entirely routed them. Great destruction was made of the Velites by the rest of the elephants, till these also being terrified, some of them ran through the void spaces of the Roman army which Scipio had left for that purpose; others falling in among the cavalry of the enemy's right wing, gave Lælius the same opportunity against the Carthaginian horse as had been given to Masinissa against the Numidian, and of which the Roman did not fail to make the same use. After this the infantry of the foremost lines joined battle. Hannibal's mercenaries had the advantage in the beginning of the conflict; but the Roman Hastati, followed and encouraged by the Principes, who exhorted them to fight manfully, and showed themselves ready to assist them, bravely sustained the attack, and at length gained ground upon the enemy. The mercenaries not being seasonably supported by their second line, and therefore thinking themselves betrayed, they in their retreat fell furiously upon the Africans; so that these, the Hastati coming up, were obliged to fight for some time both against their own mercenaries and the enemy. When the two Carthaginian lines had ceased their mutual rage, they joined their strength; and though now but a mere throng of men, broke the Hastati: but then the Principes advancing to the assistance of the latter, restored the battle; and most of the Africans and mercenaries were here cut off. Hannibal did not advance to their relief, the Roman Triarii not having yet engaged, and the Principes being still in good order; and lest the routed Africans and mercenaries should break the ranks of his Italian soldiers, he commanded these to present their spears at those who fled to them for protection, which obliged the runaways to move off to the right and left.

"The ground over which the Romans must march before they could attack Hannibal being strewed with heaps of dead bodies and weapons, and being slippery with blood, Scipio feared that the order of his battalions would be broke, should he pass it hastily. To avoid this mischief, he commanded the Hastati to give over the pursuit, and halt where they were, opposite to the enemy's centre: after which, having sent all his wounded to the rear, he advanced leisurely with the Principes and Triarii, and placed them on the wings of the Hastati. Then followed a sharp engagement, in which victory was long and eagerly disputed. It would seem that the Romans, though superior in number, were once upon the point of losing the day; for Polybius tells us, that Masinissa and Lælius came very seasonably, and as if sent from heaven, to their assistance. These generals being returned from the pursuit of the cavalry, fell suddenly upon the rear of Hannibal's men, most of whom were cut off in their ranks; and of those that fled, very few escaped the horse, the country all round being a plain.

"There died of the Carthaginians in the fight above 20,000, and almost the like number were taken prisoners. The loss on the side of the Romans amounted to about 2000 men. Hannibal escaped with a few horse to Adrumetum, having performed every thing in the engagement which could be expected from a great general. His army (says Polybius) could not have been more skilfully drawn up. For as the order of the Roman battalions makes it extremely difficult to break them, the Carthaginian wisely placed his elephants in the front, that they might put the enemy in confusion before the armies should engage. In his first line he placed the mercenaries; men bold and active, but not well

Zama ‖ Zapata.

well disciplined, that by their impetuosity he might give a check to the ardour of the Romans. The Africans and Carthaginians, whose courage he doubted, he posted in the middle between the mercenaries and his Italian soldiers, that they might be forced to fight, or at least that the Romans, by slaughtering them, might fatigue themselves and blunt their weapons. Last of all, he drew up the troops he had disciplined himself, and in whom he chiefly confided, at a good distance from the second line, that they might not be broken by the route of the Africans and mercenaries, and kept them in reserve for a vigorous attack upon a tired and weakened enemy."

ZANGUEBAR, a country in Africa, lying on the eastern coast, between three degrees of north latitude, and 18 south. It includes several petty kingdoms, in which the Portuguese have various settlements. The inhabitants, except those converted by the Portuguese, are all Mahometans or idolaters; and the latter much the more numerous. The names of the principal territories are *Mombaza*, *Lamon*, *Melinda*, *Quiola*, and *Mosambique*. The Portuguese have built several forts in Mombaza and Mosambique, and have settled several colonies there. They trade with the negroes for slaves, ivory, gold, ostrich-feathers, wax and drugs. The productions are much the same as in other parts of Africa between the tropics.

ZANONIA, a genus of plants of the class pentandria. See Botany *Index*.

ZANTE, an island of the Mediterranean, near the coast of the Morea, 19 miles south-east of the island of Cephalonia, belonging to the Ionian republic. It is about 24 miles in length and 12 in breadth, and very pleasant and fertile; but its principal riches consist in currants, with which it greatly abounds. They are cultivated in a very large plain, under the shelter of mountains on the shore of this island; for which reason the sun has greater power to bring them to perfect maturity. The town called *Zante* may contain near 20,000 inhabitants; the whole island contains about 40,000. The houses are low, on account of the frequent earthquakes, for scarce a year passes without one; however, they do no great damage. The natives speak both Greek and Italian. There are very few Roman Catholics among them; but they have a bishop as well as the Greeks. This place has no fortifications, but there is a fortress upon an eminence planted with cannon. In one part of this island is a place which shakes when trod upon like a quagmire; and a spring which throws out a great deal of bitumen, especially at the time of an earthquake. It serves instead of pitch to pay the bottoms of the ships, and about 100 barrels in a year are used for this purpose. There are about 50 villages in the island; but no other large town beside Zante. It is seated on the eastern side of the island, and has a good harbour. This and the other Ionian islands are now under the protection of Britain. E. Long. 21. 3. N. Lat. 37. 53.

ZANTHOXYLUM, the Toothache-tree, a genus of plants of the class of diœcia; and in the natural system arranged under the 46th order, *Hederaceæ*. See Botany *Index*.

ZAPATA, a kind of feast or ceremony held in Italy in the courts of certain princes, on St Nicholas's day; wherein people hide presents in the shoes or slippers of those they would do honour to, in such a manner as may surprise them on the morrow when they come to dress; being done in imitation of the practice of St Nicholas, who used in the night-time to throw purses of money in at the windows to marry poor maids withal.

Zapata ‖ Zea.

ZEA, Indian Corn; a genus of plants of the class monœcia. See Botany *Index*.—There is only one species, the *Mays*, maize. The Indians in New England, and many other parts of America, had no other vegetable but maize or Indian corn for making their bread.

They call it *weachin;* and in the United States of America there is a great proportion of the bread of the country made of this grain. In Italy and Germany also there is a species of maize which is the food of the poor inhabitants.

The ear of the maize yields a much greater quantity of grain than any of our corn ears. There are commonly about eight rows of grain in the ear, often more, if the ground be good. Each of these rows contains at least 30 grains, and each of these gives much more flour than a grain of any of our corn. The grains are usually either white or yellowish; but sometimes they are red, bluish, greenish, or olive-coloured, and sometimes striped and variegated. This sort of grain, though so essentially necessary to the natives of the place, is yet liable to many accidents. It does not ripen till the end of September; so that the rains often fall heavy upon it while on the stalk, and the birds in general peck it when it is soft and unripe. Nature has, to defend it from these accidents, covered it with a thick husk, which keeps off slight rains very well: but the birds if not frightened away, often eat through it, and devour a great quantity of the grain.

There are three or four varieties of maize in different parts of America. That of Virginia is very tall and robust, growing to seven or eight feet high; that of New England is shorter and lower. And the Indians farther up in the country have a yet smaller kind in common use. The stalk of the maize is jointed like the sugar-cane; it is very soft and juicy, and the juice is so sweet and saccharine, that a syrup, as sweet as that of sugar, has been often made of it; and things sweetened with it have been found not distinguishable from those done with sugar. It has not been tried yet whether it will crystallize into sugar; but in all probability it will.

The Americans plant this corn any time from the beginning of March to the beginning of June; but the best season is the middle of April. The savage Indians, who knew nothing of our account of months, used to guide themselves in the seed-time of this useful plant by the budding of some particular trees of that country, and by the coming up of a sort of fish into their rivers which they call the *aloofe*. These things were both so regular, that they were in no danger of mistaking the time.

The manner of planting maize is in rows, at equal distances, every way about five or six feet. They open the earth with a hoe, taking away the surface to three or four inches deep, and of the breadth of the hoe; they then throw in a little of the finer earth, so as to leave the hole four inches deep or thereabouts, and in each of these holes they place four or five grains at a little distance from one another. If two or three of these grow up, it is very well; some of them are usually destroyed either by the birds or other animals. When

When the young plants appear, they hoe up the weeds from time to time; and when the stalk gathers some strength, they raise the earth a little about it, and continue this at every hoeing till it begins to put forth the ears; then they enlarge the hill of earth, round the root, to the size of a hop-hill, and after this they leave it till the time of harvest, without any farther care. When they gather the ears, they either immediately strip off the corn, or else hang up the ears, tied in traces at distances from one another; for if they are laid near together, they will heat and rot, or else sprout and grow; but kept cool and separate, they will remain good all the winter. The best method is to thrash out the corn as soon as the harvest is over, to dry it well on mats in the sun, and then lay it up in holes of the ground, well lined with mats, grass, or the like, and afterwards covered at top with more earth. The most careful among the Indians use this method, and this sort of subterranean granary always proves good.

The uses of this plant among the Indians are very many. The great article is the making their bread of it; but besides this, the stalks, when cut up before they are too much dried, are an excellent winter food for cattle; but they usually leave them on the ground for the cattle to feed on. The husks about the ear are usually separated from the rest, and make a particular sort of fodder, not inferior to our hay. The Indian women have a way of slitting them into narrow parts, and they then weave them artificially into baskets and many other toys. The original way of eating the grain among the Indians was this: they boiled it whole in water till it swelled and became tender, and then they fed on it either alone, or ate it with their fish and venison instead of bread. After this, they found the way of boiling it into a sort of pudding, after bruising it in a mortar; but the way of reducing it to flour is the best of all. They do this by parching it carefully in the fire, without burning, and then beating it in mortars and sifting it. This flour they lay up in bags as their constant provision, and take it out with them when they go to war, eating it either dry or with water. The English have contrived, by mixing it into a stiff paste, either by itself or with rye or wheat-meal, fermenting it with leaven or yeast, and baking it in a hot oven, to make good bread of it. They have likewise found out a method of making good beer, either of the bread or by malting the grain.

ZEAL, passionate ardour for any person or cause. It is most frequently used to denote a strong and warm attachment to the distinguishing doctrines or worship of some particular sect of Christians. Thus we say, a zealous *Calvinist*, *Arminian*, or *Papist*; though we may likewise with the greatest propriety say of an upright and benevolent man, that he is zealous of *good works*.

ZEALAND, the chief of the Danish islands, is situated at the entrance of the Baltic sea, bounded by the Schaggerrac sea on the north; by the Sound, which separates it from Schonen, on the east; by the Baltic sea on the south; and by the strait called the *Great Belt*, which separates it from the island of Funen, on the west; being of a round figure, near 200 miles in circumference: the chief town is Copenhagen.

ZEALAND, is also a province of the United Netherlands, consisting of eight islands, which lie in the mouth of the river Scheldt, bounded by the province of Holland, from which they are separated by a narrow channel, on the north; by Brabant on the east; by Flanders, from which they are separated by one of the branches of the Scheldt, on the south; and by the German ocean on the west.

New ZEALAND, a country of Asia, in the South Pacific ocean, first discovered by Tasman, the Dutch navigator, in the year 1642, who gave it the name of *Staten Land*, though it has been generally distinguished in our maps and charts by the name of *New Zealand*, and was supposed to be part of a southern continent: but it is now known, from the late discoveries of Captain Cook who sailed round it, to consist of two large islands, divided from each other by a strait four or five leagues broad. They are situated between the latitudes of 34 and 48 degrees south, and between the longitudes of 166 and 180 degrees east from Greenwich. One of these islands is for the most part mountainous, rather barren, and but thinly inhabited; but the other is much more fertile, and of a better appearance. In the opinion of Sir Joseph Banks and Dr Solander, every kind of European fruits, grain, and plants, would flourish here in the utmost luxuriance. From the vegetables found here, it is supposed that the winters are milder than those in England, and the summers not hotter, though more equally warm; so that it is imagined, that if this country were settled by people from Europe, they would, with moderate industry, be soon supplied, not only with the necessaries, but the luxuries of life, in great abundance. Here are forests of vast extent, filled with very large timber trees; and near 400 plants were found here that had not been described by the naturalists. The inhabitants of New Zealand are stout and robust, and equal in stature to the largest Europeans. Their colour in general is brown, but in few deeper than that of the Spaniard who has been exposed to the sun, and in many not so deep; and both sexes have good features. Their dress is very uncouth, and they mark their bodies in a manner similar to the inhabitants of Otaheite, and which is called *tattowing*. Their principal weapons are lances, darts, and a kind of battle-axes; and they have generally shown themselves very hostile to the Europeans who have visited them.

ZEALOTS, an ancient sect of the Jews, so called from their pretended zeal for God's law and the honour of religion.

ZEBRA. See EQUUS, MAMMALIA *Index*.

ZEBU, a name given by M. de Buffon to the bos indicus of Linnæus. See MAMMALIA *Index*.

ZECHARIAH, a canonical book of the Old Testament. See SCRIPTURE, N° 80.

ZECHIN, or ZECCHINO. See SEQUIN.

ZEDOARY, in the *Materia Medica*. See KÆMPFERIA.

ZELL, a city of Germany in the circle of Lower Saxony, capital of the duchies of Zell and Lunenburg, situated at the confluence of the rivers Aller and Fuhse, 30 miles north of Hanover, and 40 south of Lunenburg. E. Long. 9. 58. N. Lat. 52. 40.

ZEMBLA, NOVA, a very large island lying in the Northern ocean, to the north of Russia, from which it is separated by the strait of Waigate. It has no inhabitants except wild beasts, particularly white foxes and bears. In 1595 a Dutch vessel was cast away on the coast, and the ship's company were obliged to winter here;

Zembla, Zemindar. here; but they did not see the sun from the fourth of November to the beginning of February, and had great difficulty to keep themselves from being frozen to death.

ZEMINDAR, in its original meaning, signifies a great landholder of Bengal; but it is now more strictly applicable to those who have their title constituted or confirmed by a patent or charter from government, by which they hold their lands or zemindaries upon certain conditions. It appears from history, that, in times prior to the irruption of the Mahomedans, the rajahs who held their residence at Delhy, and possessed the sovereignty of Hindostan, deputed officers to collect their revenues. The word *zemindar* is Persian, and that language can have had no currency in the countries of India, until it was introduced by the people of Persia. When the emperor Shehab-ul-Dien Ghory conquered the empire of Hindostan at the end of the 12th century, he left Sultan Cutub-ul-Dien to be his viceroy at Delhy, and administer the government of Hindostan. From that time the customs and practices of the Mahomedans began gradually to be established in India: their armies were sent into the countries of the reduced rajahs, under the command of omrahs, in order to preserve the conquest; and lands were allotted to them to defray the expence. From hence arose the system of Jaghiredarry in Hindostan. But when these Omrah Jaghiredars had established their own strength, several of them rebelled against the imperial authority, and aspired at the crown. Thus circumstanced, the emperors, in order to obviate these mischiefs, thought it would be more politic to commit the management of the country to the native Hindoos, who had most distinguished themselves by the readiness and constancy of their obedience to the sovereign power.

In pursuance of this plan, districts were allotted to numbers of them under a reasonable revenue (Jummah Monâsib), which they were required to pay in money to the governors of the provinces, deputed from the emperor. And in case any one of the omrahs or provincial governors should swerve from his allegiance, the zemindars of that country were to exert themselves in such a manner as should check rebellion, and restore good government. For this purpose, grants of zemindary were severally conferred upon such of the Hindoos as were obedient; describing their apportionment of the country; and every person who had received a grant under the authority of the crown was thereby fully invested with the functions of zemindar.

The functions of a zemindar are, 1st, The preservation and defence of their respective boundaries from traitors and insurgents. 2dly, The tranquillity of the subjects, the abundance of cultivators, and increase of his revenue. 3dly, The punishment of thieves and robbers, the prevention of crimes, and the destruction of highwaymen. The accomplishment of these objects is considered in the royal grant as the disharge of office to the sovereign; and on that account the word *office* (khidmut) is employed in the Dewanny Sunnud for a zemindary.

It was a rule in the times of the ancient emperors, that when any of the zemindars died, their effects and property were sequestrated by the government. After which, in consideration of the rights of long service, which is incumbent on sovereigns, and elevates the dignity of the employer, sunnuds for the office of zemindary were granted to the children of the deceased zemindar; and no other person was accepted, because the inhabitants could never feel for any stranger the attachment and affection which they naturally entertain for the family of their zemindar, and would have been afflicted if any other had been put over them. For this reason, the emperors, considering it as a means of conciliating the minds of the people, graciously fixed and confirmed the children of the deceased zemindar in the office of their fathers and grandfathers, by issuing new sunnuds to transfer the possession to them. By degrees zemindaries became truly heritable property, which, however, could be transferred by gift or sale from one family to another. They could likewise be forfeited to the sovereign, by the zemindar's deviating from his allegiance, neglecting to pay his tribute, or to discharge the duties of his station.

It is universally known, says Sir Charles Rous Boughton, that, when the three provinces of Bengal, Bahar, and Orissa, were ceded to the British East India Company, the country was distributed among the zemindars and talookdars or holders of land, who paid a stipulated revenue, by twelve instalments, to the sovereign power or its delegates. They assembled at the capital in the beginning of every Bengal year (commencing in April), in order to complete their final payments, and make up their annual accounts; to settle the discount to be charged upon their several remittances in various coins for the purpose of reducing them to one standard, or adjust their concerns with their bankers; to petition for remissions on account of storms, drought, inundation, disturbances, and such like; to make their representations of the state and occurrences of their districts: after all which they entered upon the collections of the new year; of which, however, they were not permitted to begin receiving the rents from their own farmers, till they had completely closed the accounts of the preceding year, so that they might not encroach upon the new rents, to make up the deficiency of the past. Our author proves, we think completely, the right of the zemindars to transfer their possessions, either by inheritance to their children, or, with the consent of the sovereign, to other families; and he argues strenuously and successfully against the bad policy, as well as injustice of interfering with those rights, as long as the zemindars discharge the duties of their several stations.

ZEND, or **ZENDAVESTA**, a book ascribed to Zoroaster, and containing his pretended revelations; which the ancient Magians and modern Persees, called also *Gaurs*, observe and reverence in the same manner as the Christians do the Bible, and the Mahometans the Koran, making it the sole rule both of their faith and manners. The word, it is said, originally signifies any instrument for kindling fire, and is applied to this book to denote its aptitude for kindling the flame of religion in the hearts of those who read it.

The Zend contains a reformed system of Magianism; teaching that there is a Supreme Being, eternal, self-existent, and independent, who created both light and darkness, out of which he made all other things; that these are in a state of conflict, which will continue till the end of the world; that then there shall be a general resurrection and judgment; and that just retribution shall

Zend ‖ Zeno.

shall be rendered unto men according to their works; that the angel of darkness with his followers shall be consigned to a place of everlasting darkness and punishment, and the angel of light with his disciples introduced into a state of everlasting light and happiness; after which light and darkness shall no more interfere with each other. The Zend also enjoins the constant maintenance of sacred fires and fire temples for religious worship; the distinction of clean and unclean beasts; the payment of tithes to priests, which are to be of one family or tribe; a multitude of washings and purifications, resembling those of the Jewish law; and a variety of rules and exhortations for the exercise of benevolence and charity.

In this book there are many passages evidently taken out of the Scriptures of the Old Testament, particularly out of the Psalms of David: The author represents Adam and Eve as the first parents of all mankind, gives in substance the same account of the creation and deluge with Moses, differing indeed with regard to the former, by converting the six days of the Mosaic account into six times, comprehending in the whole 365 days; and speaks also of Abraham, Joseph, Moses, and Solomon. Moreover, Dr Baumgarten asserts, that this work contains doctrines, opinions, and facts, actually borrowed from the Jews, Christians, and Mahometans; whence, and from other circumstances, he concludes that both the history and writings of this prophet were probably invented in the later ages, when the fire-worshippers under the Mahometan government thought fit to vindicate their religion from the suspicion of idolatry.

At whatever period the Zend may have been written, we are assured by Dr Hyde, that it is in the pure old Persian language, and in the character called *Peplavi*. Some parts of it contain the original text, and others Zoroaster's second thoughts subjoined, for explaining more fully his doctrine. These were occasioned by the opposition of adversaries, and unforeseen circumstances which occurred during the fabrication of the imposture. About 300 years ago, when the old Persian language had become antiquated and little understood, one of the destours or high-priests among the Persees composed the *Sadda*, which is a compendium in the vulgar or modern Persic tongue, of those parts of the Zend that relate to religion, or a kind of code of canons and precepts, drawn from the theological writings of Zoroaster, serving as an authoritative rule of faith and practice for his followers. This Sadda is written in a low kind of Persic verse, and as Dr Hyde informs us, it is *bonorum et malorum farrago*, having many good and pious things, and others very superstitious and trifling. See PERSEES and ZOROASTER.

ZENITH, in *Astronomy*, the vertical point, or a point in the heavens directly over our heads.

ZENO ELEATES, an eminent Grecian philosopher, was born at Elea about 504 years before Christ. He was a zealous friend of civil liberty, and is celebrated for his courageous and successful opposition to tyrants; but the inconsistency of the stories related by different writers concerning him in a great measure destroys their credit. He chose to reside in his small native city of Elea rather than at Athens, because it afforded freer scope to his independent and generous spirit, which could not easily submit to the restraints of authority. It is related, that he vindicated the warmth with which he resented reproach, by saying, "If I were indifferent to censure, I should also be indifferent to praise." The invention of the dialectic art has been improperly ascribed to Zeno; but there can be no doubt that this philosopher, and other metaphysical disputants in the Eleatic sect, employed much ingenuity and subtlety in exhibiting examples of most of the logical arts, which were afterwards reduced to rule by Aristotle and others.

Enfield's History of Philosophy.

Zeno

According to Aristotle, he taught, that nothing can be produced either from that which is similar or dissimilar; that there is only one being, God; who is eternal, homogeneous, and spherical, neither finite nor infinite, neither quiescent nor moveable; that there are many worlds; that there is in nature no vacuum; that all bodies are composed of four elements, heat and moisture, cold and dryness; and that the body of man is from the earth, and his soul an equal mixture of these four elements. He argued with great subtlety against the possibility of motion. If Seneca's account of this philosopher deserves credit, he reached the highest point of scepticism, and denied the real existence of external objects. The truth is, that after all that has been advanced by different writers, it is impossible to determine whether Zeno understood the term *one*, metaphysically, logically, or physically; or whether he admitted or denied a nature properly divine.

ZENO, the founder of the sect of the Stoics, was born about 300 years before Christ at Citium, in the island of Cyprus. This place having been originally peopled by a colony of Phœnicians, Zeno is sometimes called a Phœnician. His father was by profession a merchant, but discovering in the youth a strong propensity towards learning, he early devoted him to philosophy. In his mercantile capacity he had frequent occasion to visit Athens, where he purchased for his son several of the writings of the most eminent Socratic philosophers. These he read with great avidity; and when he was about 30 years of age, he determined to take a voyage to a city which was so celebrated both as a mart of trade and of science. If it be true, as some writers relate, that he brought with him a valuable cargo of Phœnician purple, which was lost by shipwreck upon the coast of Piræus, this circumstance will account for the facility with which he at first attached himself to a sect whose leading principle was the contempt of riches. Upon his first arrival in Athens, going accidentally into the shop of a bookseller, he took up a volume of the Commentaries of Xenophon; and after reading a few passages, was so much delighted with the work, and formed so high an idea of the author, that he asked the bookseller where he might meet with such men. Crates the Cynic philosopher happening at that instant to be passing by, the bookseller pointed to him, and said, "Follow that man." Zeno attended upon the instructions of Crates, and was so well pleased with his doctrine that he became one of his disciples. But though he admired the general principles of the Cynic school, he could not easily reconcile himself to their peculiar manners. Besides, his inquisitive turn of mind would not allow him to adopt that indifference to every scientific inquiry which was one of the characteristic distinctions of the sect. He therefore attended upon other masters, who professed to instruct their disciples in the nature and causes of things. When Crates, displeased at his following other philosophers, attempted to drag him by force out of the school of Stilpo, Zeno said

Zeno, Zenobia.

said to him, "You may seize my body, but Stilpo has laid hold of my mind." After continuing to attend upon the lectures of Stilpo several years, he passed over to other schools, particularly to those of Xenocrates and Diodorus Cronus. By the latter he was instructed in dialectics. He was so much delighted with this branch of study, that he presented to his master a large pecuniary gratuity, in return for his free communication of some of his ingenious subtleties. At last, after attending almost every other master, he offered himself as a disciple of Polemo. This philosopher appears to have been aware, that Zeno's intention in thus removing from one school to another, was to collect materials from various quarters for a new system of his own; for, when he came into Polemo's school, he said to him, "I am no stranger, Zeno, to your Phœnician arts; I perceive that your design is to creep slyly into my garden, and steal away my fruit." Polemo was not mistaken in his opinion. Having made himself master of the tenets of others, Zeno determined to become the founder of a new sect. The place which he made choice of for his school was a public portico, adorned with the pictures of Polygnotus, and other eminent painters. It was the most famous portico in Athens, and called, by way of eminence, Στοα, "the Porch." It was from this circumstance that the followers of Zeno were called *Stoics*.

In his person Zeno was tall and slender; his aspect was severe, and his brow contracted. His constitution was feeble, but he preserved his health by great abstemiousness. The supplies of his table consisted of figs, bread, and honey; notwithstanding which, he was frequently honoured with the company of great men. In public company, to avoid every appearance of an assuming temper, he commonly took the lowest place. Indeed so great was his modesty, that he seldom chose to mingle with a crowd, or wished for the company of more than two or three friends at once. He paid more attention to neatness and decorum in external appearance than the Cynic philosophers. In his dress indeed he was plain, and in all his expences frugal; but this is not to be imputed to avarice, but a contempt of external magnificence. He showed as much respect to the poor as to the rich; and conversed freely with persons of the meanest occupations. He had only one servant, or, according to Seneca, none.

Zeno lived to the extreme age of 98; and at last, in consequence of an accident, voluntarily put an end to his life. As he was walking out of his school he fell down, and in the fall broke one of his fingers; upon which he was so affected with a consciousness of infirmity, that, striking the earth, he said, "Why am I thus importuned? I obey thy summons;" and immediately went home and strangled himself. He died in the first year of the 129th Olympiad. The Athenians, at the request of Antigonus, erected a monument to his memory in the Ceramicum.

We ought not to confound the two Zenos already mentioned with

ZENO, a celebrated Epicurean philosopher, born at Sidon, who had Cicero and Pomponius Atticus for his disciples, and who wrote a book against the mathematics, which, as well as that of Possidonius's refutation of it, is lost; nor with several other Zenos mentioned in history.

ZENOBIA, queen of Palmyra. See PALMYRA.

ZEOLITE, a mineral substance. See MINERALOGY *Index*.

Zeolite, Zeuxis.

ZEPHANIAH, a canonical book of the Old Testament. See SCRIPTURE, N° 79.

ZEPHYR, the *West-Wind*, or that which blows from the cardinal point of the horizon opposite to the east.

ZEPHYRUS, one of the Pagan deities, was represented as the son of Aurora, and the lover of the nymph Chloris, according to the Greeks, or of Flora according to the Romans; and as presiding over the growth of fruits and flowers. He is described as giving a refreshing coolness to the air by his soft and agreeable breath, and as moderating the heat of summer by fanning the air with his silken wings. He is depictured under the form of a youth, with a very tender air, with wings resembling those of the butterfly, and with his head crowned with a variety of flowers. As the poets of Greece and Rome lived in a warm climate, they are lavish in their praise of this beneficent deity, and under his name describe the pleasure and advantage they received from the western breezes.

ZERDA. See CANIS, MAMMALIA *Index*.

ZERTA, the ZERTE, a fish caught in the rivers of Italy and some other places, of the figure of the chub, and called by authors *capito anodromus*, and the *blike*. It seldom grows to more than two pounds weight, and at times lives in rivers, at times in the sea; and is esteemed a very well tasted fish, especially a little before the season of its spawning. The zerte is that species of cyprinus described by Gesner and others under the name of *capito anodromus*.

ZEST, the woody thick skin quartering the kernel of a walnut; prescribed by some physicians, when dried and taken with white wine, as a remedy against the gravel.

ZEST is also used for a chip of orange or lemon peel; such as is usually squeezed into ale, wine, &c. to give it a flavour; or the fine oil which spurts out of that peel on squeezing it.

ZEUGMA, a figure in *Grammar*, whereby an adjective or verb which agrees with a nearer word, is also, by way of supplement, referred to another more remote.

ZEUS, a genus of fishes of the order of *thoracici*. See ICHTHYOLOGY *Index*.

ZEUXIS, a celebrated painter of antiquity, flourished about 400 years before Christ. He was born at Heraclea; but as there have been many cities of that name, it cannot be certainly determined which of them had the honour of his birth. Some learned men, however, conjecture, that it was the Heraclea near Crotona in Italy. He carried painting to a much higher degree of perfection than Apollodorus had left it; discovered the art of properly disposing of lights and shades, and particularly excelled in colouring. He amassed immense riches; and then resolved to sell no more of his pictures, but gave them away; saying very frankly, "That he could not set a price on them equal to their value." Before this time he made people pay for seeing them; and nobody was admitted to see his Helena without ready money, which occasioned the wags calling his picture *Helen the Courtezan*. It is not known whether this Helen of Zeuxis was the same with that which was at Rome in Pliny's time, or that which he painted for the inhabitants

inhabitants of Crotona to be hung up in the temple of Juno: this last he painted from five beautiful girls of that city, copying from each her greatest excellencies. Pliny observes, that this admirable painter, disputing for the prize of painting with Parrhasius, painted some grapes so naturally, that the birds flew down to peck them. Parrhasius, on the other hand, painted a curtain so very artfully, that Zeuxis, mistaking it for a real one that hid his rival's work, ordered the curtain to be drawn aside, to show what Parrhasius had done; but having found his mistake, he ingenuously confessed himself vanquished, since he had only imposed upon birds, while Parrhasius had deceived even a master of the art. Another time he painted a boy loaded with grapes; when the birds also flew to this picture, at which he was vexed; and confessed, that his work was not sufficiently finished, since, had he painted the boy as perfectly as the grapes, the birds would have been afraid of him. Archelaus, king of Macedon, made use of Zeuxis's pencil for the embellishment of his palace. One of this painter's finest pieces was a Hercules strangling some serpents in his cradle, in the presence of his affrighted mother: but he himself chiefly esteemed his Athleta, or Champion, under which he placed a Greek verse that afterwards became very famous, and in which he says, "That it was easier to criticise than to imitate the picture." He made a present of his Alcmena to the Agrigentines. Zeuxis did not value himself on speedily finishing his pictures; but knowing that Agatharchus gloried in his being able to paint with ease and in a little time, he said, "That for his part he, on the contrary, gloried in his slowness; and, if he was long in painting, it was because he painted for eternity." Verrius Flaccus says, that Zeuxis having painted an old woman, he laughed so very heartily at the sight of this picture, that he died: but as no other of the ancients has mentioned this particular, there is the greatest reason to believe it fabulous. Carlo Dati has composed in Italian the Life of Zeuxis, with those of Parrhasius, Apelles, and Protogenes. This work was printed at Florence in 1667.

ZICLAG, or ZIKLAG, in *Ancient Geography*, a town of the tribe of Simeon, on the borders of the Philistines (Joshua xv. and xix.), but in the hands of the Philistines till David's time (1 Sam. xxvii. and xxx.).

ZIMENT-WATER, COPPER-WATER, the name by which some have called water found in places where there are copper-mines, which is impregnated with particles of that metal.

The most famous spring of this kind is about a mile distant from Newsohl in Hungary, in the great copper-mine called by the Germans *Herrngrundt*. The water in this mine is found at different depths, and is received into basons, for the purpose of separating the copper from it: in some of these it is much more sated with this metal than in others, and will make the supposed change of iron into that metal much sooner. The most common pieces of iron used in the experiments are horse-shoes, nails, and the like; and they are found very little altered in shape, after the operation, except that their surfaces are more raised. The water appears greenish in the bason, where it stands; but if a glass of it be taken up, it looks clear as crystal; it has no smell, but a strong vitriolic astringent taste, insomuch that the lips and tongue are blistered and scorched upon tasting it.

ZIN, in *Ancient Geography*, a wilderness encompassing Idumea, at least on the south and west, as far as Palestine or Canaan; but according to Wells, on the east of Edom, to the north of Ezion-gaber.

ZINC, a metallic substance, formerly considered as one of the brittle metals; or, according to the distinction of the older chemists, a *semi-metal* or an imperfect metal, because it was found to be destitute of some of the properties of other metals which were considered as perfect. For an account of the properties and combinations of zinc, as they were then known, see CHEMISTRY *Index*; and for the history of its ores, see MINERALOGY *Index*.

But in the progress of chemical discovery it has been found that zinc is not a less perfect metal than others; for in the year 1805, it was announced that a patent was granted to Messrs Hobson and Sylvester of Sheffield for a method of manufacturing zinc. From their discovery it appears, that zinc raised to a temperature of between 210° and 300° of Fahrenheit, is not only very malleable, but may be passed through rollers, or drawn into wire. After the metal has been treated in this manner, it does not return to its former brittleness, but continues soft, flexible, and extensible, and may be applied to many uses for which this metal was before thought unfit *.

We must, however, notice, that a prior claim to the discovery of rendering zinc ductile and malleable, has been made by Mr Lowry, in favour of a Mr Sheffield of Somerstown. Twenty years before the time of Messrs Hobson and Sylvester's patent being announced, Mr Sheffield, in making an assay of some blende, was impatient to examine the metal, struck an ingot for the purpose of breaking it while it was yet hot, but was much surprised to find that instead of being brittle, and breaking with the usual fracture of zinc, it was extremely tough, and when he succeeded in breaking it, after many bendings backward and forward, it exhibited a steel-grained fibrous texture. At first he doubted of the metal being zinc, but he repeated the experiment on what he knew to be pure metal, and obtained the same result; and from this he concluded that zinc at a certain temperature is equally malleable and ductile with other metals. This he found to be the case by drawing it into wire, and laminating it between rollers, by which he produced plates not exceeding the $\frac{1}{100}$th of an inch, and possessing the strength and tenacity of silver †.

* *Phil. Mag.* xxiii. 92.

† *Phil. Mag.* xxiii. 282.

Since the time that our article CHEMISTRY was printed, the decomposition of potash, soda, the alkaline earths, and some other bodies which were formerly considered as simple, or were only conjectured from analogy to be compound, has been effected by Mr Davy; and as we were disposed to entertain hopes that something new might be added to the unexpected and brilliant discoveries of that celebrated chemist, we have deferred, till near the close of our work, giving any account of them. This is the reason that the fact was merely announced under the words POTASH and SODA, and a reference made to *Galvanic* TROUGH, under which it was intended to give a short description of the apparatus employed in the experiments which led to the discoveries alluded to. For the same reason we were induced to make a farther reference to this place, because zinc is one

Zinc. one of the metallic substances usually employed in the construction of galvanic apparatus. We shall therefore here employ a few pages, 1st, In a description of the improvements which have been made in the construction of galvanic apparatus; and, 2d, We shall lay before our readers a view of the discoveries in galvanic electricity since the treatises on CHEMISTRY and GALVANISM in this work were printed.

Galvanic Apparatus.—A very considerable improvement has been made on the construction of galvanic batteries, by which they are rendered, not only more convenient and manageable, but far more powerful. Under the article GALVANISM, we have described particularly the construction of the galvanic trough, and we have noticed that the soldering of the plates of zinc and copper employed for this purpose was attended with considerable difficulty. In the new method of construction the plates are not soldered together, but are merely connected by means of a metallic arc. In this way each pair of plates can be removed from the trough at pleasure, for the purpose of examining and cleaning them. The new apparatus is constructed precisely on the same principle as the *couronne de Tasses*, proposed by Volta, and described at p. 333 of GALVANISM. The trough employed in this apparatus is prepared in the same way as when the plates of zinc and copper soldered together were fixed in it by means of cement; but in place of the metallic plates, plates of glass, or some other non-conducting substance, are introduced and secured by cement, so that there shall be no communication between the different cells into which the liquid is introduced. The plates of zinc and copper connected by means of the metallic arc, at the distance of about half an inch, are placed in different cells, having a plate of glass between each pair of plates. Each cell then contains a plate of each of the metals, which are unconnected, excepting through the medium of the liquid which is to be the conductor of the electricity. It is scarcely necessary to mention, that the proper order of arrangement shall be observed, so that throughout the whole trough or battery there shall be a series of zinc, copper, and liquid.

Beside the conveniency and simplicity of this mode of constructing galvanic troughs, it possesses this farther advantage of being more powerful, because instead of one surface of the plates, as in the former construction of this apparatus, both surfaces are exposed to the action of electricity, and therefore the power is greatly increased. A farther improvement, it is said, has been made in constructing batteries of this kind, which consists in employing troughs of Wedgewood's ware, with partitions of the same material, instead of wooden troughs with partitions of glass. This improvement was first suggested by Dr Babington.

The following is the account of the construction of galvanic apparatus, with the view of ascertaining in what way the greatest effect might be produced, with the least waste of power and expence. The experiments which we are now to mention were made by Mr Children *. For this purpose a battery was constructed on the new method, with plates of copper and zinc, connected by leaden straps, soldered on the top of each pair of plates. Twenty pairs of plates were employed, and each plate was four feet high by two feet wide. The whole extent of surface exposed amounted to 92,160 square inches; the trough was made of wood, with wooden partitions, covered with cement, to resist the action of the acid employed. The battery was charged with a mixture of three parts of fuming nitrous, and one of sulphuric acid, diluted with thirty of water; the quantity employed was 120 gallons. With this apparatus the following experiments were made.

* Phil Trans. 1809, p. 32.

Exper. 1. Eighteen inches of platina wire, of one-thirtieth of an inch diameter, were completely fused in about twenty seconds. *Exper.* 2. Three feet of the same wire were heated to a bright red, visible by strong day-light. *Exper.* 3. Four feet of the same wire were rendered very hot, but not perceptibly red by day-light. *Exper.* 4. Charcoal burnt with intense brilliancy. *Exper.* 5. Ten inches of iron-wire of $\frac{1}{70}$th of an inch diameter, were barely fused; three feet of the same wire were not ignited. *Exper.* 6. No effect was produced on imperfect conductors. *Exper.* 7. The gold leaves of the electrometer were not affected. *Exper.* 8. When the cuticle was dry, no shock was given by the battery, and it was scarcely perceptible when the skin was wet.

To contrast the effects of this apparatus with another differing in the size and number of plates, the anther employed 200 pairs of plates, each about two inches square, placed in half pint pots of common queen's ware. The same liquid was employed, with the addition of a fresh portion of sulphuric acid, in the proportion of about a quarter of a pint to a gallon. The experiments with this apparatus gave the following results.

Exper. 1. Potash and barytes were readily decomposed. *Exper.* 2. The metallization of ammonia was produced with great facility. *Exper.* 3. Charcoal was vividly ignited. *Exper.* 4. The gold leaves of the electrometer diverged considerably. *Exper.* 5. After the battery was in action three hours, it gave a vivid spark; at the end of 24 hours it metallized ammonia; at the end of 41 hours it was nearly exhausted. From the results of these experiments, Mr Children concludes, that the theory of the mode of action of the voltaic battery proposed by Mr Davy is confirmed, namely, that the intensity increases with the number, and the quantity with the extent of the series. This is proved by the effects produced on the platina and iron wires, in the 1st and 5th experiments with the large battery, as well as by the experiments on imperfect conductors in the small apparatus; for as the platina wire is a perfect conductor, and not liable to oxidation, it allows the electricities to be freely transmitted, and from the immense quantity given out from a surface of such extent, they evolve, on their mutual annihilation, heat sufficient to raise the temperature of the platina to the point of fusion. But a very small portion of the electricity passes through the iron wire, in consequence of its easy oxidation, and the thin coat of oxide formed on its surface. This arises from the low state of the intensity of the electricity, as appears also from its want of power on the gold leaves of the electrometer. From the same deficient intensity, the decomposition of barytes could not be effected by the large battery, and the same battery exhibited a very weak action on imperfect conductors; but the small battery exerted great power on that class of bodies, and decomposed them readily, although its surface was 30 times less than the surface of the great battery; but the number

Zinc. ber of plates was nearly ten times greater. Another circumstance, of considerable importance in conducting experiments by means of the galvanic battery, is here noticed by the author; that the long continued action of the small battery was owing to the large capacity of the cells containing a proportional quantity of liquor. And beside this advantage he adds, that with very large combinations, a certain distance between each pair of plates is absolutely necessary to prevent spontaneous discharges, which are accompanied with vivid flashes of electric light. This happened to the author with a battery of 1250 four inch plates, constructed according to the new method. Mr Children has constructed a battery of 20 pairs of six feet high and $2\frac{1}{7}$ broad, and with this battery he ignited 6 feet of platina wire.

From the experiments and observations, some of which we have detailed, and for others we refer to the paper itself, the author concludes with the following remarks: "The absolute effect of a voltaic apparatus seems to be in the compound ratio of the number and size of the plates. The intensity of the electricity being as the former, the quantity given out as the latter, consequently regard must be had, in its construction, to the purposes for which it is designed. For experiments on perfect conductors, very large plates are to be preferred, a small number of which will probably be sufficient; but where the resistance of imperfect conductors is to be overcome, the combination must be great, but the size of the plates may be small: but if quantity and intensity be both required, then a large number of large plates will be necessary. For general purposes, four inches square will be found to be the most convenient size*." *Ibid.* 37.

Discoveries in Galvanism.—At the close of the article Galvanism, we noticed some experiments which were made about the beginning of the year 1805, which seemed to lead to the conclusion, that muriatic acid and soda were formed by means of galvanic electricity. In experiments on the decomposition of water, which was supposed to be in a state of the utmost purity, the appearance of muriatic acid and soda was adduced in support of this opinion. The accuracy of this conclusion, which seemed to be at variance with known facts, excited doubt, and probably led to the investigation which was undertaken by Mr Davy, and carried on with great ingenuity and address by the same philosopher, till it terminated in the brilliant discoveries, an account of which we are now to detail. Mr Davy's researches in galvanism, an account of which he laid before the Royal Society in a memoir entitled, *On some Chemical Agencies of Electricity*, may be considered as the first step in this train of investigation.

With the view of disproving the accuracy of the experiments in which the generation of acids and alkalies was supposed to have been effected by means of galvanism, Mr Davy employed agate cups, (fig. 1.), of a cylindrical form, and containing about one-fourth of a cubic inch each. The cups were boiled for some hours in distilled water, and a piece of white transparent amianthus, which had been treated in the same way, was made to connect them. They were then filled with distilled water, and exposed by means of two platina wires, to a current of electricity, from 150 pairs of plates of copper and zinc, four inches square. The liquid employed was a solution of alum. The action continued 48 hours, and the process was then examined. Paper tinged with litmus introduced into the tube con- Plate DLXXVIII. fig. 1.

taining the positive wire, was reddened; paper coloured by turmeric placed in the other tube, had its colour deepened; the acid matter produced a slight turbidity in a solution of nitrate of silver; the fluid from the negative tube retained the property of affecting the turmeric after being boiled, and indeed became more vivid as the quantity was diminished by evaporation. Carbonate of ammonia was added, and the whole being dried, and exposed to a strong heat, a minute quantity of white matter remained, which had all the properties of carbonate of soda. Zinc.

The same experiment was repeated with glass tubes, and the result was, that the quantity of alkali obtained was 20 times greater, but no traces of muriatic acid could be perceived. Mr Davy suspecting that the agate might contain a minute portion of saline matter, repeated the experiment four times. The quantity of alkaline matter diminished in every operation, and in the last process, although the battery had been kept in great activity for three days, the fluid possessed in a slight degree only the power of acting on paper tinged with turmeric; but its alkaline property was very sensible to litmus paper slightly reddened. The acid matter in the other tube was abundant; it had a sour taste, and produced no effect on solution of muriate of barytes, but left a black stain from a drop on a polished plate of silver. Thus it appeared to be extremely diluted nitrous acid.

For the purpose of making the experiment with greater accuracy, two hollow cones of pure gold (fig. 2.) Fig. 2. were employed, each containing about 25 grains of water. They were filled with distilled water, connected by moistened amianthus, as before, and exposed to the action of a battery of 100 pairs of plates of six inches square. The liquid used was a solution of alum, and diluted sulphuric acid. In ten minutes the water in the negative tube changed litmus paper to a slight blue, and the water in the positive tube produced a red tint. The process having continued for 14 hours, the acid was found to increase in quantity during the whole time, but the alkaline fluid in the other tube did not affect the tests more than in the first trial. The acid seemed to be the pure nitrous, with an excess of nitrous gas. The experiment was repeated, and the process carried on for three days, and similar results were obtained. From these experiments it was concluded, that the distilled water contained a minute portion of saline matter, but so minute indeed, that it was insensible to the most delicate chemical tests. This appeared to be the case by evaporating a quantity of the distilled water that was used very slowly, at a heat below 140° Fahrenheit, in a silver still. A quantity of solid matter equal to seven-tenths of a grain, of a saline but metallic taste, was obtained. It seemed to be a mixture of nitrate of soda and nitrate of lead. Mr Davy then employed some of the water collected in the second process of slow distillation, in another experiment with the gold tubes and connecting amianthus. At the end of two hours the water in the negative tube had no effect on turmeric paper; litmus, it could just be perceived, was changed; but by heating the water strongly for two or three minutes, it was deprived even of this power, and from this he supposes that it was owing to a small quantity of ammonia. A similar experiment was made with a portion of the same water in the agate tubes, and precisely the same results were obtained. From these

Zinc. experiments Mr Davy fairly concludes, that the fixed alkali is not generated during the process, but merely evolved, either from the solid materials employed, or some saline matter in the water.

Many experiments were made in vessels composed of different substances, with the water procured by slow distillation; and in almost every instance some fixed alkali appeared. When tubes of wax were employed, the alkaline matter was a mixture of soda and potash, and the acid matter, a mixture of sulphuric, muriatic, and nitric acids. A tube of resin afforded alkaline matter, which was principally potash. A cube of Carrara marble of about an inch, having an aperture in its centre, was placed in a platina crucible, which was filled as high as the upper surface of the cube, with the purified water. The aperture was filled with the same liquid, and the crucible was positively electrified by a powerful battery, and the negatively electrified wire introduced into the aperture. Fixed alkali and lime were obtained in this experiment; the quantity of alkali diminishing as the experiment was repeated, and after 11 processes, each continued for two or three hours, disappeared altogether. The quantity of lime-water obtained was uniform.

When 500 grains of this marble were analyzed, they afforded about three-fourths of a grain of fixed saline matter, having soda for its base. Suspecting that the Carrara marble might have been recently exposed to sea water, Mr Davy subjected to a similar experiment, a piece of granular marble from the mountains of Donnegal, and by means of negative electricity he obtained fixed alkali. Argillaceous schistus from Cornwall gave the same result, and serpentine and gray wacken both afforded soda.

In other experiments Mr Davy subjected other bodies to the action of the same power, with the view of effecting a decomposition. Thus, two cups of compact sulphate of lime, each containing about 14 grain measures of water, were connected by fibrous sulphate of lime moistened with pure water. The cups were filled with the same fluid, and they were introduced into the circuit of a galvanic battery with 100 pairs of plates of six inches. In five minutes the water in the positive cup became acid, while that in the opposite cup tinged tumeric. An hour after, a saturnine solution of lime was formed in the negative cup, and the other contained a solution of sulphuric acid of moderate strength.

Two cubical pieces of crystallized sulphate of strontites, of about an inch, with a hole drilled in each, capable of receiving eight grains of water, were plunged in pure water, in a platina crucible, and the level of the fluid was kept a few lines below the surface of the cubes. The holes in the earthy mineral were filled with pure water, and two platina wires were introduced into them. At the end of thirty hours the fluid in the cavity of the negative side precipitated solution of sulphate of potash, and sulphuric acid appeared in the other.

Two pieces of fluate of lime, having each a cavity, and connected by moist asbestus, were subjected to a similar experiment. The decomposition was slow; but in two days a solution of lime appeared in the one tube, and an acid in the other, which precipitated acetate of lead, and left a spot upon the glass, from which it was evaporated, so that it must have been fluoric acid.

Compact zeolite being prepared in the same way, and electrified in the same manner as the cube of Carrara marble, afforded soda and lime. Lepidolite, by similar treatment, gave potash; and an alkaline matter, which seemed to be a mixture of soda, potash and lime, was extracted from a piece of vitreous lava from Mount Etna.

The decomposition of saline bodies, which are soluble in water, was more rapid. A diluted solution of sulphate of potash introduced into the agate cups connected by amianthus moistened with pure water, being electrified by a battery with 50 pairs of plates, produced in four hours a weak solution of potash in the negative cup, and a solution of sulphuric acid in the positive cup. Similar phenomena were observed when sulphate of soda, nitrate of potash, nitrate of barytes, sulphate of ammonia, phosphate of soda, succinate, oxalate, and benzoate of ammonia and alum, were employed. The acids in a certain time collected in the tube containing the positive wire, and the alkalies and earths in the negative tube. Solutions of the muriatic salts, subjected to decomposition by the same processes, uniformly afforded oxymuriatic acid on the positive side.

Saturated saline solutions were most rapidly decomposed, but the smallest proportion was also acted on. Thus, if a piece of paper tinged with turmeric be plunged into pure water, in a proper circuit, in contact with the negative point, the minute quantity of saline compound contained in the paper, produces instantly a brown tint near its point of contact. Acid appears also from litmus paper at the positive surface.

Experiments were made with the view of ascertaining whether in these processes the separation of the constituent parts was complete, from the last portions of the compound. The following experiment shows that this is the case. "A very weak solution of sulphate of potash, containing 20 parts of water, and one part of saturated solution at 64°, was electrified in the two agate cups, by the power of 50 pairs of plates for three days; the connecting amianthus which had been moistened with pure water, was removed, washed with pure water, and again applied twice every day. By this precaution the presence of any neutral salt that might adhere to it, and disturb the results, was prevented. The alkali obtained in this process in the solution had the properties of pure potash, and when it had been saturated with nitric acid, it gave no turbidness by mixture with solution of muriate of barytes; the acid matter exposed to a strong heat, evaporated, without leaving any residuum."

Mr Davy then made experiments on the transfer of certain of the constituent parts of bodies, and also on the passage of acids, alkalies, and other substances, through various attracting chemical menstrua, by means of electricity, and in these experiments he obtained many curious and interesting results; but for an account of them, as well as of his observations on the different phenomena, and on the mode of decomposition and transition, we must refer to the memoir itself.

After the investigations in which Mr Davy had been occupied, and the singular and unexpected results which he obtained, he ventured to conclude, from the general principles on which the phenomena might be explained, that the new methods of proceeding would lead to a more intimate knowledge concerning the true elements of of bodies. Accordingly, in November 1807, he laid before the Royal Society a most interesting detail of an elaborate series of experiments on the decomposition of the alkalies.

Decomposition of the Alkalies.

In the first attempts that were made on the decomposition of potash, Mr Davy employed an aqueous solution, saturated at a common temperature. It was exposed to the action of a powerful galvanic battery, composed of 24 plates of copper and zinc of 12 inches square, 100 plates of six inches, and 150 plates of four inches square, charged with solutions of alum and nitrous acid. The action was very intense; a great deal of heat and violent effervescence were produced, but the water only of the solution was effected, and its hydrogen and oxygen were disengaged. Potash in the state of igneous fusion, in a spoon of platina, was next subjected to the action of a battery of 100 plates of six inches, highly charged. The spoon was connected with the positive side. In this experiment some brilliant phenomena were produced. The potash appeared to be a good conductor; and, while the communication was preserved, a most intense light was emitted from the negative wire, and a column of flame, seemingly owing to the developement of combustible matter, arose from the point of contact. When the order was reversed, and the platina spoon was connected with the negative side, a vivid and constant light appeared at the opposite point. There was no inflammation round it; but aeriform globules, which inflamed in the atmosphere, rose through the potash. The platina was considerably acted on.

Although potash, when perfectly dry, be a non-conductor, it acquires a conducting power by being slightly moistened. A small piece of pure potash exposed for a few seconds to the atmosphere, was placed on a disc of platina connected with the negative side of a battery of 250 plates of six and four inches, in a state of intense activity. A platina wire from the opposite side was brought in contact with the upper surface of the alkali. A vivid action soon took place. The potash fused at both points of electrisation; a violent effervescence appeared at the upper surface; but at the lower or negative surface no elastic fluid was emited, but small globules like quicksilver were produced, some of which burnt with explosion and bright flame as they were formed, and others remained and were only tarnished, and finally covered by a white film formed on their surfaces. These globules were the basis of potash. The same results were obtained, when gold and other metals, plumbago, or charcoal, were employed; and the effects were the same when the process was conducted in an exhausted receiver.

Mr Davy also obtained the same substance from potash, fused by means of a lamp, and placed in glass tubes confined by mercury, and furnished with hermetically inserted platina wires, to transmit the electricity; but the glass was rapidly dissolved by the action of the alkali, so that the process could not be long carried on.

In these experiments on potash, the combustible base was produced from the negative surface, and oxygen was evolved from the positive surface. The same effects invariably followed, when the experiment was conducted above mercury. The same thing was proved synthetically. The combustible substance obtained from the potash had its metallic lustre destroyed in the atmosphere, and a white crust formed upon it. This crust was found, upon examination, to be pure potash; but this was still farther confirmed by placing globules of the combustible matter in tubes containing common air, or oxygen gas, confined by mercury. An absorption of the oxygen took place, and a crust of alkali was formed upon the globule. When the combustible matter confined in given portions of oxygen, was strongly heated, a rapid combustion, with a brilliant white flame, was produced, and the metallic globules were converted into a white and solid mass, which was found to be pure potash.

To the combustible matter thus obtained from potash, Mr Davy gave the name of *potassium*. From its strong affinity for oxygen, it was extremely difficult to preserve it unchanged, for the purpose of examining its properties. The substance which he found to be least affected, is newly distilled naphtha. In this fluid potassium may be kept for many days nearly unaltered, and its physical properties may be examined in the atmosphere, when covered by a thin film of it.

Potassium, at 60° Fahrenheit, is in the form of small globules, which have the metallic lustre and general appearance of mercury; at 70° it becomes more fluid, and at 100°, different globules easily run into one. At 50° of Fahrenheit it is soft and malleable, and exhibits the lustre of polished silver. At 32° it becomes hard and brittle, and, when, broken, presents a crystallized texture. To reduce it to vapour, it requires a red heat; and in proper circumstances, it may be subjected to distillation, without change. It is a good conductor of heat, and a perfect conductor of electricity.

In the properties now mentioned, potassium approaches nearly to the metals; but it is very different in its specific gravity. In naphtha of the specific gravity of 861 it rose to the surface; and it did not sink in double distilled naphtha, the specific gravity of which was about .770. From these and other experiments, Mr Davy estimates the specific gravity of potassium at .6, so that it is the lightest fluid body known. In its solid form it is somewhat heavier; but, even in this state, when cooled to 40° Fahrenheit, it swims in double distilled naphtha.

With the view of ascertaining the proportions of the constituent parts of potash, Mr Davy made two experiments, by subjecting the metallic base to combustion in oxygen gas. In the first experiment, .12 of a grain of potassium were employed; the combustion was made upon platina, and was rapid and complete, and the basis appeared to be perfectly saturated. The result of this experiment indicates 86.7 of basis, and 13.3 of oxygen, in the 100 parts of potash. In another experiment, the result he obtained was 85.5 of basis, and 14.5 of oxygen. The mean of these two experiments is 86.1 of basis, and 13.9 of oxygen, in 100 parts of potash.

The results of the decomposition of water by the basis of the alkalies, which were more readily and perfectly obtained than those of their combustion, exhibited the proportion of base to be 84, and that of oxygen 16; but the mean of 86.1 of base, and 13.9 of oxygen, and 84 base and 16 oxygen, is 85 of potassium and 15 of oxygen, which may be taken as the proportions of the elements of potash.

Mr Davy's discoveries have been confirmed by the ingenious

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genious experiments of Thenard and Gay-Lussac. These distinguished chemists have decomposed potash by a different process. They introduced iron filings into a bent gun barrel, which was placed across a furnace. A tube with a stopcock, containing a quantity of solid potash, is connected with one extremity of the gun barrel; to the other extremity there is attached a tube of safety, containing mercury, for the purpose of excluding the atmospheric air, and allowing any gaseous matter formed during the process to escape. The potash in the tube is to be kept cold by means of a freezing mixture, till that part of the barrel containing the iron filings has been raised to a white heat. The potash is then fused by applying heat, by means of a portable furnace; and it is allowed to pass through a small opening, to come in contact with the iron filings, where it is decomposed, the oxygen of the potash entering into combination with the iron, and the base passing on to the other extremity of the tube in a state of sublimation. At that extremity the metallic base is condensed by the application of excessive cold, and in this way the potassium may be obtained at less expence, and in greater quantity, than by means of galvanism. During this progress, hydrogen gas is evolved, which, it is supposed, is owing to the decomposition of the water contained in the alkali. The potassium thus obtained is in the form of brilliant laminæ, which adhere to the sides of the gun barrel. An alloy of the same metal with iron is also found in that part of the barrel containing the filings. Mr Davy has repeated this experiment, and he finds that the base obtained in this manner is heavier, and its melting point higher, than what is procured by means of galvanism. This, it is supposed, may arise from its being combined with a small proportion of iron. The metallic base of soda was obtained by a similar process.

But, according to the view which the French chemists have taken of these discoveries, and the results of their own experiments, they conclude, that the metallic substances derived from the alkalies are not simple, but are compounds of the several bases with hydrogen.

Another method of decomposing potash, and obtaining its base, which is still simpler, has been followed by Curaudau. In this process the decomposition is effected by charcoal. A mixture of carbonate of potash is made with flour or charcoal and linseed oil. This mixture is introduced into an iron or earthen tube or retort, and calcined, by gradually raising the heat, till a bluish light be seen in the inside of the vessel. Soon after an abundant evolution of vapour takes place, which is the base of the alkali, to be collected by introducing a clean iron rod, on which it condenses. Care must be taken to withdraw the rod before it is too hot, and to plunge it in oil of turpentine, under the surface of which the metallic crust on the rod may be separated. In this way a quantity of potassium may be procured. The base of soda is obtained by a similar process.

Fig. 3. Fig. 3. is a representation of the apparatus employed by the French chemists in decomposing potash. ABCE is the gun barrel laid across the furnace, with its apparatus; D is the furnace, and F is the pipe of the bellows.

Fig. 4. Fig. 4. is a section of the tube containing the potash.

But the chemical relations of potassium are not less extraordinary than its physical properties. It combines slowly with oxygen, and without flame, at all temperatures below that of its vaporization. At this point combustion takes place, with a brilliant white light, and intense heat. When it is heated slowly in a quantity of oxygen gas, which is not sufficient for its complete saturation, and at a temperature below that of inflammation, as for instance 400° of Fahrenheit, it changes to a red brown colour, and the solid form, consisting partly of potash, and partly of its base, is of a grayish colour. When exposed to water, or again heated in fresh quantities of air, the whole is converted into potash. When dry potash and potassium are fused together under proper circumstances, the base is deprived of its metallic splendour, and the two substances unite into a compound of a red brown colour when fluid, and of a dark gray when solid. This compound, when exposed to the air, soon absorbs its full proportion of oxygen, and is wholly converted into potash. The substance thus formed seems to be in a lower state of oxidation, so that it is to be considered as an oxide of potassium with a smaller proportion of oxygen.

When potassium is introduced into oxymuriatic acid gas, it burns spontaneously with a bright red light, and a white salt is formed, which is muriate of potash. When a globule of potassium is heated in hydrogen gas, at a degree below its point of vaporization, it seems to dissolve in it, for the globule is diminished in volume, and the gas explodes with alkaline fumes, and bright light, when brought into the air; but, by cooling, the potassium is wholly or principally deposited, for the gas is deprived of its property of spontaneous detonation.

When potassium is thrown into water, it decomposes it with great violence; an instantaneous explosion, with brilliant flame, is produced, and a solution of pure potash is obtained. In these experiments, a white ring of smoke, gradually extending as it rises in the air, is produced, similar to the phenomenon of the combustion of phosphorated hydrogen. When a globule of the basis of potash is placed upon ice, it instantly burns with a bright flame; part of the ice is melted, and in the cavity there is found a solution of potash.

By placing a globule of potassium upon moistened paper, tinged with turmeric, the moment that it comes in contact with the water, it burns, and, moving rapidly upon the paper, leaves behind it a deep reddish brown trace, thus demonstrating, in a very simple manner, the production of the alkali by the decomposition of water.

Potassium readily decomposes the small quantities of water contained in alcohol and ether, even in their purest state. As potash is insoluble in ether, when the base is thrown into it, oxygen is furnished to it, and hydrogen gas evolved, and, as the alkali is formed, the ether becomes white and turbid. It is observed, that the energy of action of potassium in ether and alcohol, is proportional to the quantity of water which they contain, and hydrogen and potash are always produced.

When potassium is thrown into solutions of the mineral acids, it inflames and burns on the surface, and when plunged, by proper means, beneath the surface enveloped in potash, surrounded by naphtha, it acts upon the oxygen with great intensity. In sulphuric acid, a white saline substance, covered with a yellow coating, which is supposed to be sulphate of potash surrounded with sulphur, and a gas, having the smell of sulphureous acid, and

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and which is probably a mixture of that substance with hydrogen gas, are formed. When potassium is thrown into nitrous acid, nitrate of potash is formed, and nitrous gas is disengaged.

Potassium readily combines with phosphorus and sulphur. When pressed upon a piece of phosphorus, they both become fluid, enter into combustion, and produce phosphate of potash. When the experiment is made upon naphtha, no gaseous substance is given out; the compound has the appearance of a metallic phosphuret, is of the colour of lead, and has the lustre of polished lead. Exposed to the air at common temperatures, it combines slowly with oxygen, and is converted into phosphate of potash. When heated upon a plate of platina, it gives out fumes, but does not burn till it reaches the temperature of the rapid combustion of potassium.

When potassium is brought into contact with sulphur in fusion, in tubes filled with the vapour of naphtha, they combine rapidly, with the evolution of heat and light. A gray substance is thus formed, which has the appearance of artificial sulphuret of iron; if it be kept in fusion, it rapidly dissolves the glass. When this experiment is made in a glass tube, hermetically sealed, no gas is disengaged, if the tube be opened under mercury; but when it is made in a tube connected with a mercurial apparatus, a small quantity of sulphurated hydrogen is evolved. When the combination is effected in the atmosphere, a great inflammation takes place, and sulphuret of potash is formed, and by farther exposure to the air, it is at last converted into sulphate of potash.

When one part of potassium is added to eight or ten of mercury, in bulk, at 60° of Fahrenheit, they instantly unite, and form a substance like mercury in colour, but less coherent. When a globule is made to touch a globule of mercury about twice as large, they combine with considerable heat. The compound is fluid at the temperature of its formation, but, when cool, it becomes solid, with the appearance of silver. With the $\frac{1}{70}$th of potassium to the weight of mercury, the amalgam is hard and brittle; but with one part of potassium, and 70 of mercury, it is soft and malleable. Exposed to the air, these compounds absorb oxygen, and deliquescent potash is formed; and in a few minutes the mercury is revived. A globule of the amalgam, thrown into water, decomposes it rapidly with a hissing noise; potash is formed; pure hydrogen is disengaged, and the mercury remains free. This amalgam dissolves all the metals, and even acts on iron and platina.

When potassium is heated with gold, silver, or copper, in a close vessel of pure glass, a rapid action is produced, and the compounds thrown into water effect its decomposition; potash is formed, and the metals are revived. Potassium forms an alloy with fusible metal, which has a higher point of fusion than the fusible metal itself.

Potassium has little effect on colourless and recently distilled naphtha: but, in naptha, exposed to the air, it is soon oxidated, and an alkali which unites with the naphtha into a brown soap that collects round the globule, is formed. Potassium acts slowly on the concrete oils, as tallow, spermaceti, and wax, even when heated; coaly matter is deposited, a little gas is evolved, and a soap is formed. On the fluid fixed oils the effects are similar, but take place more slowly. With the assistance of heat, volatile oils are rapidly decomposed by potassium; gas is evolved, and charcoal deposited.

The metallic oxides, when heated in contact with potassium, are readily reduced. When a small quantity of oxide of iron was heated with it, to a temperature approaching its point of distillation, a vivid action took place. Alkali, in gray metallic particles, which effervesced in muriatic acid, appeared. The oxides of lead and tin were revived more rapidly, and with potassium in excess, an alloy was formed with the revived metal.

Potassium readily decomposes flint glass and green glass, by a gentle heat. The metallic oxides are reduced, and the alkali formed dissolves the glass. At a red heat, even the purest glass is acted on by potassium; the oxygen in the alkali of the glass seems to be divided between the potassium employed, and the potassium which is the base of the alkali in the glass, and thus effects an oxidation in the first degree.

Soda.—When pure soda was subjected in similar circumstances to the action of galvanism, similar results were obtained as from potash; but the decomposition required a more intense action in the battery, or it was necessary to have the alkali in thinner and smaller pieces. Potassium remained fluid at the temperature of the atmosphere, at the time of its production; but the base obtained from soda, which was fluid in the degree of heat of the alkali during its formation, became solid on cooling, and exhibited the lustre of silver. With a battery of 100 pairs of plates of six inches, in full activity, the decomposition of pieces of soda of about 15 to 20 grains in weight only could be effected; and it was necessary also that the distance between the wires should not exceed one-eighth or one-tenth of an inch. But when 250 pairs of plates were employed, highly charged for the decomposition of soda, the globules often burnt at the moment of their formation, and sometimes exploded and separated into smaller globules, which darted rapidly through the air, in a state of vivid combustion, producing a beautiful effect of continued jets of fire.

When the metallic base which is obtained from soda, and which Mr Davy has denominated *sodium*, was exposed to oxygen, it was converted into soda; and when this process was conducted by strongly heating the base in a given portion of oxygen, a rapid combustion with a brilliant white flame was produced, and the metallic globule was converted into a white solid mass, which was found to be soda. The oxygen gas was absorbed during the operation, and nothing was given out which affected the purity of the residual air.

The theory of the decomposition of the alkalies is stated by Mr Davy in the following words. "As in all decompositions of compound substances which I had previously examined, at the same time that combustible bases were developed at the negative surface in the electrical circuit, oxygen was produced, and evolved or carried into combination at the positive surface, it was reasonable to conclude, that this substance was generated in a similar manner by the electrical action of the alkali; and a number of experiments made above mercury, with the apparatus for excluding external air, proved that this was the case. When solid potash or soda, in its conducting state, was included in glass tubes, furnished with electrified platina wires, the new substances

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were generated at the negative surfaces; the gas given out at the other surface proved, by the most delicate examination, to be pure oxygen; and, unless when excess of water was present, no gas was evolved from the negative surface.

For the purpose of determining the proportions of the elements of soda, Mr Davy made experiments similar to those by which he ascertained the proportions of the base and oxygen of potash. By subjecting sodium to combustion in oxygen gas, it appeared that 100 parts of soda are composed of 80 of metallic base, and 20 of oxygen; but the results of its oxidation by the decomposition of water, indicated the proportions to be 23 of oxygen, and 77 of base. By taking the mean proportions, obtained from the results of the two sets of experiments, the elements of soda may be estimated at 78.5 of metallic base, and 21.5 of oxygen.

Sodium, which remains solid at common temperatures, is white and opaque; and examined under a film of naphtha, has the lustre and appearance of silver. It is very malleable, and softer than common metallic substances. With a slight pressure it spreads into thin leaves, and a globule of one-tenth or one-twelfth of an inch in diameter, is easily spread over a surface of one-fourth of an inch; and different globules are easily made to adhere, and form one mass by strong pressure. This property of welding which belongs to iron and platina at a white heat only, is not diminished when sodium is cooled to 32° Fahrenheit.

Sodium, like potassium, is a conductor of electricity and heat, and small globules subjected to galvanism inflame and burn with bright explosions. Sodium sinks in naphtha of specific gravity .861; but by mixing perfectly about 12 parts of naphtha, and five of oil of sassafras, the sodium remains at rest in any part of the fluid. This makes its specific gravity = about .9348, water being taken as 1. The particles of sodium lose their cohesion at 120° Fahrenheit. It becomes quite fluid at 180°, so that it readily fuses under boiling naphtha. The temperature at which it is volatilized is not ascertained, but it remains fixed in a state of ignition at the point of fusion of plate glass.

The chemical relations of sodium are analogous to those of potassium, but with some characteristic differences. Exposed to the atmosphere, it is immediately tarnished, and is gradually covered with a white crust, which is pure soda. It combines slowly with oxygen, and without any luminous appearance at common temperatures. When heated, the combination is more rapid, but no light is emitted till it acquire a temperature near that of ignition. The flame in oxygen gas is white, and it sends forth bright sparks, producing a very beautiful effect; in common air, the colour of the light is like that of the combustion of charcoal, but brighter. When sodium was heated in hydrogen gas, it seemed to have no action on it.

Sodium burns vividly in oxymuriatic acid gas, giving out numerous sparks of a bright red colour; a saline matter is produced, which is muriate of soda. When sodium is thrown into water, it produces a violent effervescence with a loud hissing noise; it combines with the oxygen of the water to form soda, which is dissolved, and its hydrogen is disengaged. During the process there is no luminous appearance; but when sodium is thrown into hot water, a more violent decomposition takes place. A few scintillations are observed at the surface of the water, which is owing to small particles of the basis which are thrown out of the water, heated to such a degree as to burn in passing through the atmosphere. But when a globule of sodium is brought into contact with a small particle of water, or with moistened paper, the heat produced is usually sufficient for its combustion, as in this case there is no medium to carry off the heat rapidly.

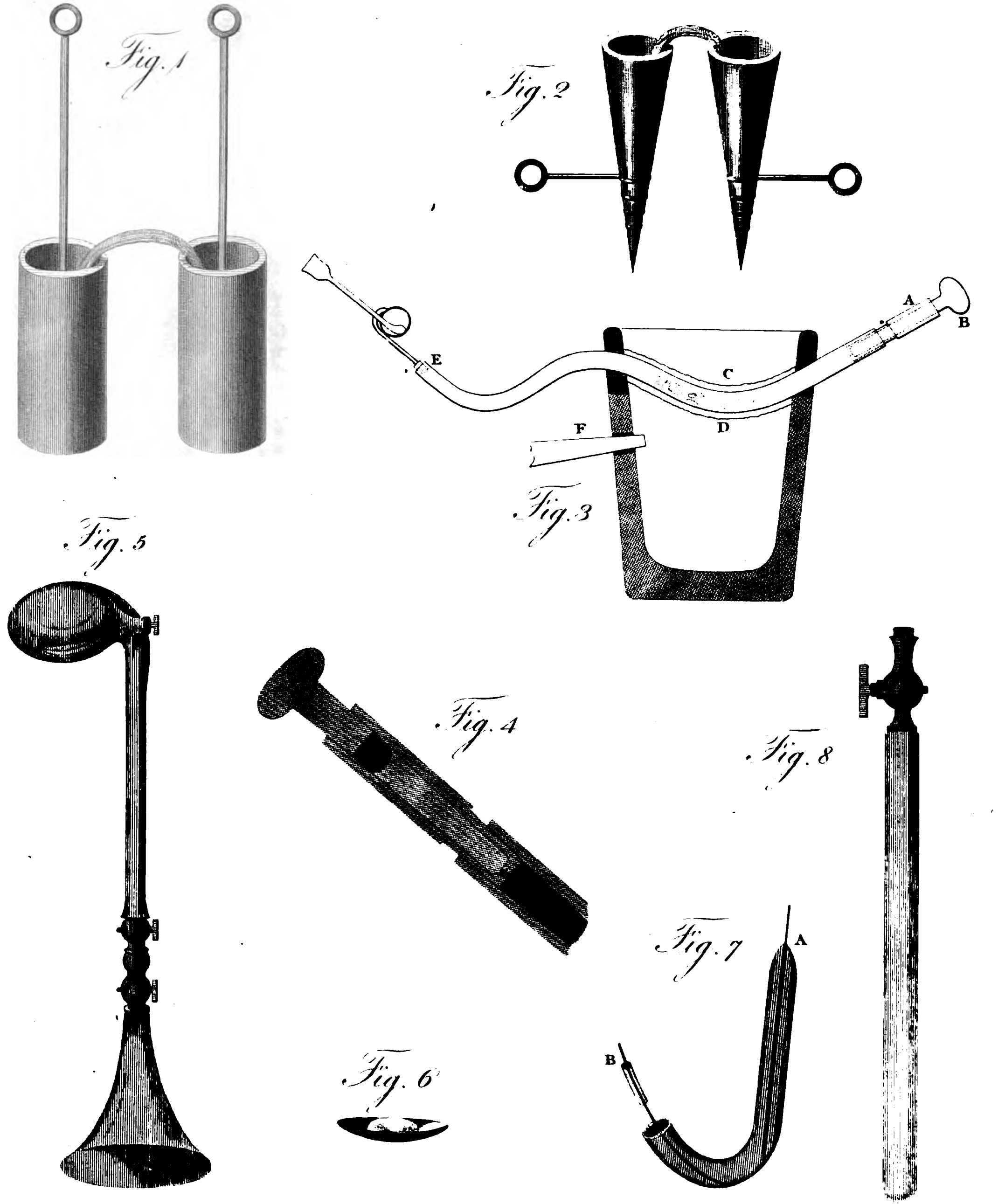
Sodium produces similar effects with potassium when brought into contact with alcohol and ether. It acts with great energy on the strong acids; with nitrous acid it produces a vivid inflammation, and with muriatic and sulphuric acids, great heat, but no light, is generated. The effects of sodium and potassium on the fixed and volatile oils, and naphtha, are quite analogous; but the appearances of the saponaceous compounds are somewhat different, the combinations with sodium being of a darker colour, and apparently less soluble.

Sodium also exhibits two degrees of combination with oxygen; the first is of a deep brown colour, which is fluid when produced, and becomes a dark gray solid on cooling. By attracting oxygen from the air, or by the decomposition of the water, it is converted into soda.

Sodium forms compounds with sulphur and phosphorus. In close vessels filled with the vapour of naphtha, it enters into combination with sulphur, giving out during the process a vivid light and heat, and often attended with explosion, from the vaporization of a portion of sulphur, and the disengagement of sulphurated hydrogen gas. The sulphuret of sodium is of a deep gray colour. In its combination with phosphorus, the compound obtained has the appearance of lead, and by exposure to the air, or by being subjected to combustion, the phosphuret of sodium is converted into phosphate of soda.

Sodium forms compounds with the metals. In the proportion of one-fortieth with mercury, a compound is obtained, which is of the colour of silver, and remains solid; the combination is accompanied with considerable heat. Sodium forms an alloy with tin, without producing any change of colour, and it has some action upon lead and gold when heated; but in its state of alloy it is soon converted into soda, by exposure to the air, or by the action of water, which it decomposes with disengagement of hydrogen. The amalgam of mercury and sodium seems to be capable of forming triple compounds with some other metals; and it would appear that iron and platina remain in combination with the mercury, after they are deprived of the sodium by exposure to the air. The same amalgam of sodium and mercury likewise forms combinations with sulphur; the triple compound thus obtained is of a dark gray colour.

Ammonia.—The chemical composition of ammonia has been many years considered as fully established; but in the course of Mr Davy's experiments on the decomposition of the fixed alkalies, it occurred to him that oxygen might also form one of the constituents of ammonia, and this he also proved by experiment. Charcoal carefully burnt, and deprived of moisture was ignited by a galvanic battery of 250 pairs of plates of six and four inches square, in a small quantity of pure ammoniacal gas, confined over mercury. A great expansion of the gaseous matter took place, and the white substance



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substance formed in the process collected on the sides of the glass tube. This matter effervesced in diluted muriatic acid, so that the product was probably carbonate of ammonia. A more decisive proof of ammonia containing oxygen as one of its elements, was obtained from another process. Very pure ammoniacal gas was passed over iron wire ignited in a platina tube, and two curved glass tubes were so arranged as to be inserted into a freezing mixture, and through one of these tubes the gas entered into the platina tube, to be conveyed through it by the other glass tube into an air-holder. The temperature of the air was 55°, and no sensible quantity of water was deposited in the cooled glass tube, which transmitted the unchanged ammonia. But after being exposed to heat, moisture was very perceptible, and the gas appeared in the air-holder densely clouded. This circumstance appeared to establish the formation of the water from the decomposition of ammonia during the process. But after the gas had been passed several times through the ignited tube, from one air-holder to the other, the iron wire was found superficially converted into oxide, and had increased in weight $\frac{44}{100}$ of a grain. About four-tenths of a grain of water were collected from the cooled glass tubes by means of filtrating paper, and 33.8 cubic inches of gas were expanded into 55.3 cubic inches, and by detonation with oxygen it was found, that the hydrogen gas in these was to the nitrogen or azote as 3.2 to 1 in bulk.

Ammonia was farther subjected to experiment by taking the electric spark in it. In experiments of this kind it was understood that it is resolved into hydrogen and azotic gases; but Mr Davy, found, after observing several variations in the results, that the weight of the two gases obtained was less by about one-eleventh than the weight of the ammonia employed. He ascribes this loss to the oxygen of the alkali, which had probably combined with the wires of platina employed in the experiment, and had thus disappeared. From these experiments he estimates the proportion of oxygen in ammonia at no less than 7 or 8 parts in 100; and as the gases evolved may contain more water than the gas decomposed, the proportion may even be larger. By thus considering ammonia as a triple compound of azote, hydrogen, and oxygen, the phenomena of its production and decomposition admit of an easy explanation. In all cases in which ammonia is formed, oxygen exists along with its other elements, in the substances from the decomposition of which it is obtained. In the decomposition of ammonia, on the other hand, the oxygen which forms one of its elements, may be abstracted by the substance employed in its decomposition, or it may enter into combination with portions of its hydrogen or azote.

But in the progress of investigating the nature of ammonia, to which the attention of chemical philosophers has been particularly directed, it appears that this alkali is analogous to the fixed alkalies in having a metallic base. The Swedish chemists Berzelius and Pontin, placed mercury negatively electrified in the galvanic circle, in contact with solution of ammonia. By this action the mercury increased in volume, and after an expansion of four or five times its former dimensions, it became a soft solid. From this amalgam exposed to the air, mercury and ammonia are reproduced, with the absorption of oxygen; and when the amalgam is put into water it forms ammonia, with the evolution of hydrogen, and the re-appearance of the mercury in its metallic state. Mr Davy repeated this experiment, and he found that to produce an amalgam, from 50 or 60 grains of mercury, in contact with a saturated solution of ammonia, required a considerable time, and that this amalgam changed considerably, even in the short period that was necessary for removing it from the solution. Conceiving that the de-oxidation and combination with mercury might be more easily effected in its nascent state, he placed 50 grains of mercury in a cavity in muriate of ammonia. The muriate slightly moistened was placed on a plate of platina, and connected with the positive side of a large galvanic battery. The mercury was made negative by means of a platina wire; a strong effervescence, with much heat, immediately took place; the globule of mercury in a few minutes enlarged to five times its former dimensions. It had the appearance of amalgam of zinc. Metallic crystallizations shot from it as a centre round the body of salt. They had an arborescent appearance, often became coloured at their points of contact with the muriate, and when the connection was broken, rapidly disappeared, while ammoniacal fumes were given out, and the mercury was reproduced. With a piece of carbonate of ammonia, similar phenomena were exhibited. The amalgam was formed very rapidly; but when the galvanic action was powerful in this last case, a black matter appeared in the cavity, which was probably carbone, from the decomposition of the carbonic acid.

Mr Davy considering the strong attraction of potassium and sodium for oxygen, was led to examine whether they produced any effect in the amalgamation of ammonia, independent of electricity. With this view he united small portions of potassium and sodium with mercury, and brought them into contact with moistened muriate of ammonia. An amalgam was formed, which rapidly increased to six or seven times its volume, and the compound seemed to contain a larger proportion of ammoniacal base than that obtained by electricity. It appears, too, that a portion of the metallic base employed to effect the de-oxidation always remained in combination with the compound, so that it was not a pure amalgam. The following are the properties of the amalgam from ammonia, obtained by means of galvanism.

When this amalgam is formed at the temperature of 70° or 80°, it is in the state of a soft solid, of the consistence of butter; at 32° it becomes firmer, and assumes a crystallized form, in which small facets appear, which seem to be cubical. The amalgam of potassium crystallizes in cubes, as beautiful, and in some cases as large, as those of bismuth. The specific gravity of the amalgam is less than three, water being one. When the amalgam is thrown into water, a quantity of hydrogen equal to half its bulk, is evolved, and the water becomes a weak solution of ammonia. The amalgam being confined in a given portion of air, the air increases in bulk, and the mercury is revived. Ammoniacal gas equal to $1\frac{1}{7}$ or $1\frac{1}{7}$ths of the volume of the amalgam, is produced, and oxygen equal to one-seventh or one-eighth of the ammonia, disappears. When the amalgam is thrown into muriatic acid gas, it becomes instantly coated with muriate of ammonia, and a small portion of hydrogen is evolved. In sulphuric acid it becomes

Zinc. becomes coated with sulphate of ammonia, and sulphur.

Mr Davy attempted, by various methods, to preserve the amalgam, in the hope of submitting it to distillation, for the purpose of obtaining the metallic base of the ammonia, which was united to the mercury, in a separate form. But as it is extremely difficult to free mercury, after being once moistened, entirely from water, he did not succeed in this attempt. In wiping the amalgam carefully with bibulous paper, part of the ammonia was regenerated, and in passing it through fine linen, with the view of separating the moisture, a complete decomposition was effected, and the mercury was revived.

The quantity of the base of ammonia combined with 60 grains of quicksilver, appears not to exceed $\frac{1}{200}$ of a grain, and the quantity of oxygen required for this is not more than $\frac{1}{1000}$ of a grain of water, which might be supplied by merely breathing upon the amalgam. Mr Davy made various other experiments, with the view of ascertaining the nature and properties of the amalgam of ammonia; but for an account of these we must refer to the paper itself. And he observes, that the more these properties are considered, the more extraordinary will they appear. Mercury, by combination with about $\frac{1}{12000}$ of its weight of new matter, becomes solid, and yet has its specific gravity reduced from 13.5 to less than 3, retaining at the same time its metallic characters, its colour, lustre, opacity, and conducting powers, undiminished. Can it then be conceived, Mr Davy asks, that a substance which forms with mercury so perfect an amalgam, should not be metallic in its own nature? This substance he denominates *ammonium*. On what then, it is farther asked, do the metallic properties of ammonium depend? Are hydrogen and nitrogen both metals in the gaseous state, at the usual temperature of the atmosphere; bodies of the same character, as zinc and mercury in the state of ignition? Or are these gases in their common form oxides which become metallized by de-oxidation? Or are they to be considered as simple bodies, not metallic in their own nature, but capable of composing a metal when deprived of oxygen, and becoming an alkali with the addition of oxygen?

In the farther prosecution of the experiments relative to the nature of ammonia, Mr Davy employed potassium. He brought ammonia into contact with about twice its weight of potassium at common temperatures; but excepting a slight diminution in the volume of the gas, and the metal losing its lustre and becoming white, no other effects were produced. The white crust when examined, proved to be potash, and a small portion of hydrogen was found in the ammonia, but not more than equal in volume to the metal. When the potassium was heated in the gas, by means of a spirit lamp applied to

Fig. 5. the bottom of the retort, (fig. 5.) the colour of the crust changed from white to bright azure, and gradually to bright blue, green, and dark olive. The crust and the metal then fused together. This process is attended with effervescence; and the crust passing off to the sides, exhibits the shining surface of the potassium. When heated a second time, it swells considerably, becomes porous, crystallized, and of a beautiful azure tint. A gas is evolved during this operation, which gives the same diminution by detonation with oxygen, as hydrogen, and ammonia disappears.

It has been observed that the proportion of ammonia which loses its elastic form, varies according as the gas employed contains more or less moisture. Thus, in ammonia saturated with water at 63° Fahrenheit, potassium caused the disappearance of twelve and a half cubical inches of ammonia; but in ammonia deprived of moisture, by exposure for two days to potash that had been ignited, the same quantity of potassium occasioned the disappearance of 16 cubical inches; but whatever were the degrees of moisture of the gas, the quantity of hydrogen generated always appeared equal for equal quantities of metal; and according to the French chemists, the proportions are stated to have been the same as would have resulted from the action of water upon potassium. But in Mr Davy's experiments, the proportions were rather less. In one, conducted with great care, eight grains of potassium generated, by their action upon water, eight and a half cubical inches of hydrogen gas; and eight grains of potassium from the same mass, by their operation upon ammonia, produced $8\frac{1}{8}$ cubical inches of hydrogen gas. This difference, although inconsiderable, Mr Davy found always to take place.

In Mr Davy's experiments on the action of potassium on ammonia, he employed retorts of plate glass. The potassium was fastened upon trays of platina or iron, which were introduced into the glass retorts furnished with stop-cocks. The retorts were exhausted by an air-pump, then filled with hydrogen, exhausted a second time, and afterwards filled with ammonia. (See fig. 5. and 6.). Fig. 5. and 6.

The following are the properties of the substance obtained from the action of ammonia on potassium. 1. It is crystallized, and presents irregular facets, which are extremely dark, and in colour and lustre not unlike the green oxide of iron; it is opaque when examined in large masses, but is semitransparent in thin films, and appears of a bright brown colour by transmitted light. 2. It is fusible at a heat a little above that of boiling water, and if heated much higher, emits globules of gas. 3. It appears to be considerably heavier than water, for it sinks rapidly in oil of sassafras. 4. It is a non-conductor of electricity. 5. When it is melted in oxygen gas, it burns with great vividness, emitting bright sparks. Oxygen is absorbed, nitrogen is emitted, and potash, which from its great fusibility seems to contain water, is formed. 6. When brought into contact with water, it acts upon it with much energy, produces heat, and often inflammation, and evolves ammonia. When thrown upon water, it disappears with a hissing noise, and globules from it often move in a state of ignition upon the surface of the water. It rapidly effervesces and deliquesces in air, but can be preserved under naphtha, in which, however, it softens slowly, and seems partially to dissolve. When it is plunged under water filling an inverted jar, by means of a proper tube, it instantly disappears with effervescence, and the non-absorbable elastic fluid liberated is found to be hydrogen gas.

It is found that the weight of this substance is greater than that of the potassium from which it is formed; and from this it is concluded, that part of the ammonia, or of its elements, enters into its composition. When this substance is decomposed by heat, nitrogen and hydrogen gases, with a portion of ammonia, are given out. It appears, however, that the production of the ammonia is is in proportion to the moisture admitted, and when the moisture is considerable, the whole product is ammonia. When this substance is exposed to heat, a matter remains, which even by increasing the heat, is no farther changed. On this residuum water acts violently, and with effervescence, from the evolution of hydrogen gas. Ammonia and potash are at the same time reproduced. Mr Davy's conclusion from these experiments is, that the substance formed by the action of ammonia on potassium is a compound of the latter with a small proportion of oxygen and nitrogen; and as it is found that the quantity of hydrogen given out during its formation is nearly equal to the hydrogen contained in the ammonia, it follows that neither hydrogen nor the ammonia itself can be supposed to enter into its composition.

In prosecuting this investigation, Mr Davy made various experiments, and whether the substance was acted on by water, exposed to the action of oxygen, or decomposed by heat, it was found, contrary to expectation, that the quantity of nitrogen evolved during its decomposition was much less than in proportion to the quantity of ammonia which had disappeared in its formation. In one experiment, in which the decomposition was effected by heat, the gaseous product was examined, and was found to be partly potash, and partly potassium; but it afforded no traces of ammonia, when acted on by water, which is a proof that it retained no nitrogen. In another experiment, 11 cubic inches of ammonia, or 2.05 grains, were decomposed by potassium. The product was 3.6 cubic inches of nitrogen, equal to 1.06 grain; 16 cubic inches of hydrogen, equal to .382 grain; and there was added to the potassium a quantity of oxygen equal to .6 grain. These products taken together amount to 2.04 grains, which is nearly equal to the quantity of ammonia employed; but this quantity of ammonia, if the proportions of its elements be estimated, from its decomposition by electricity, would have yielded 5.5 cubic inches of nitrogen, equal to 1.6 grain, and only 14 cubic inches equal to .33; and allowing the separation of oxygen in this process in water, it cannot be estimated at more than .11 or .12; and hence, if the analysis of ammonia by electricity come near to accuracy, there is in this process a considerable loss of nitrogen, and the production of oxygen and hydrogen.

How, says Mr Davy, can these extraordinary results be explained? The decomposition and composition of nitrogen seem proved, and one of its elements appears to be oxygen; but what is the other element? Is the gas that appears to possess the properties of hydrogen a new species of inflammable aeriform substance? Or has nitrogen a metallic basis, which alloys with the iron or platina? Or is water alike the ponderable matter of nitrogen, hydrogen, and oxygen? Or is nitrogen a compound of hydrogen, with a larger proportion of oxygen than exists in water? Of these important questions, Mr Davy adds, the two first seem the least likely to be answered in the affirmative, from the correspondence between the weight of the ammonia decomposed, and the products, supposing them to be known substances.

In concluding this subject, we must observe, that it still remains in a considerable degree of obscurity. It seems, however, to be ascertained, that the base of ammonia is of a metallic nature, which must be derived, either from the nitrogen or the hydrogen, or from both, or perhaps these substances are only different forms of combination of the elementary base. Or if nitrogen be supposed to be an oxide of hydrogen, then hydrogen in its gaseous form is either a metallic substance, or has a metallic base, which latter enters into combination with the mercury employed in the decomposition of ammonia.

Decomposition of the Earths.

From the results of the experiments on potash and soda, which Mr Davy obtained, he was led to entertain the strongest hopes of being able to effect the decomposition both of the alkaline and common earths; and the phenomena which took place in the first imperfect trials made upon these bodies countenanced the ideas, that had obtained since the earliest periods of chemistry, of their being metallic in their nature.

The earths, like the fixed alkalies, are non-conductors of electricity; but the fixed alkalies become conductors by fusion: the infusible nature of the earths, however, rendered it impossible to operate upon them in this state: the strong affinity of their bases for oxygen, made it unavailing, to act upon them in solution in water; and the only methods that proved successful, were those of operating upon them by electricity in some of their combinations, or of combining them at the moment of their decomposition by electricity in metallic alloys, so as to obtain evidences of their nature and properties. To render the experiments upon the earths satisfactory, a more powerful battery will be required, than Mr Davy has a prospect of seeing very soon constructed; he therefore prefers the imputation of having published unfinished labours, to that of having concealed any new facts.

Barytes, strontites, and lime, slightly moistened, were electrified by iron wires under naphtha, by the same methods, and with the same powers, as those employed for the decomposition of the fixed alkalies. In these cases gas was copiously evolved, which was inflammable; and the earths, where in contact with the negative metallic wires, became dark coloured, and exhibited small points, having a metallic lustre, which, when exposed to air, gradually became white: they became white likewise when plunged under water; and when examined in this experiment with a magnifier, a greenish powder seemed to separate from them, and small globules of gas were disengaged.

In these experiments there was great reason to believe that the earths had been decomposed; and that their bases had combined with the iron, so as to form alloys decomposable by the oxygen of the air or water; but the indistinctness of the effect, and the complicated circumstances required for producing it, were such as to compel Mr Davy to form other plans of operation.

Mr Davy bearing in mind the strong attraction of potassium for oxygen, was induced to try whether this body might not detach the oxygen from the earths, in the same manner as charcoal decomposes the common metallic oxides. He heated potassium in contact with dry pure lime, barytes, strontites, and magnesia, in tubes of plate-glass; but as he was obliged to use very small quantities, and as he could not raise the heat to ignition without fusing the glass, he obtained no good results in this manner.

Zinc. manner. The potassium appeared to act upon the earths and on the glass, and dark brown substances were obtained, which evolved gas from water; but no distinct metallic globules could be procured: from these, and other like circumstances, it seemed probable, that though potassium may partially deoxigenate the earths, yet its affinity for oxygen, at least at the temperature employed, is not sufficient to effect their decomposition. Mr Davy, having made mixtures of dry potash in excess and dry barytes, lime, strontites, and magnesia, brought them into fusion, and acted upon them in the galvanic circuit in the same manner as he employed for obtaining the metals of the alkalies. He expected that the potassium and the metals of the earths might be deoxigenated at the same time, and enter into combination in alloy.

In this way of operating, the results were more distinct than in the last: metallic substances appeared less fusible than potassium, which burned the instant after they had formed, and which by burning produced a mixture of potash and the earth employed. An attempt was made to form the metallic substances under naphtha, but without much success. To produce the result at all, required a charge by the action of nitric acid, which the state of the batteries would not often allow of; and the metal was generated only in very minute films, which could not be detached by fusion, and which were instantly destroyed by exposure to air.

Mr Davy had found in his researches upon potassium, that when a mixture of potash and the oxide of mercury, tin, or lead, was electrified in the galvanic circuit, the decomposition was very rapid, and an amalgam, or an alloy of potassium, was obtained; the attraction between the common metals and potassium apparently accelerating the separation of the oxygen. The idea that a similar kind of action might assist the decomposition of the alkaline earths, induced him to electrify mixtures of these bodies and the oxide of tin, of iron, of lead, of silver, and of mercury; and these operations were far more satisfactory than any of the others.

A mixture of two-thirds of barytes, and one-third of oxide of silver very slightly moistened, was electrified by iron wires; an effervescence took place at both points of contact, and a minute quantity of a substance, possessing the whiteness of silver, formed at the negative point. When the iron wire to which this substance adhered, was plunged into water containing a little alum in solution, gas was disengaged, which proved to be hydrogen; and white clouds, which were found to be sulphate of barytes, descended from the point of the wire.

A mixture of barytes and red oxide of mercury, in the same proportions was electrified in the same manner. A small mass of solid amalgam adhered to the negative wire, which evidently contained a substance, that produced barytes by exposure to the air, with the absorption of oxygen; and which occasioned the evolution of hydrogen from water, leaving pure mercury, and producing a solution of barytes.

Mixtures of lime, strontites, magnesia, and red oxide of mercury, treated in the same manner, gave similar amalgams, from which the alkaline earths were regenerated by the action of air or water, with like phenomena; but the quantities of metallic substances obtained were exceedingly minute; they appeared as mere superficial formations surrounding the point of the wire, nor did they increase after the first few minutes of electrization, even when the process was carried on for some hours.

These experiments were at first made when the batteries were in bad order; but were afterwards resumed with a new and much more powerful apparatus, constructed in the laboratory of the Royal Institution, and consisting of five hundred pairs of double plates of six inches square.

When Mr Davy attempted to obtain amalgams with this apparatus, the transmitting wires being of platina, of about $\frac{1}{70}$ of an inch diameter, the heat generated was so great as to burn both the mercury and basis of the amalgam at the moment of its formation; and when, by extending the surface of the conductors, this power of ignition was modified, yet still the amalgam was only procured in thin films, and globules sufficiently large to submit to distillation could not be procured. When the transmitting wires were of iron of the same thickness, the iron acquired the temperature of ignition, and combined with the bases of the earths in preference to the mercury; and metallic alloys of a dark gray colour were obtained, which acted on water with the evolution of hydrogen, and were converted into oxide of iron and alkaline earths.

While Mr Davy was engaged in these experiments, he received a letter from Professor Berzelius of Stockholm, who stated that in conjunction with Dr Pontin, he had succeeded in decomposing barytes and lime, by negatively electrifying mercury in contact with them, and that in this way he had obtained amalgams of the metals of these earths.

Mr Davy immediately repeated these operations with perfect success; a globule of mercury, electrified by the power of the battery of 500, weakly charged, was made to act upon a surface of slightly moistened barytes, fixed upon a plate of platina. The mercury gradually became less fluid, and after a few minutes was found covered with a white film of barytes, and when the amalgam was thrown into water, hydrogen was disengaged, the mercury remained free, and a solution of barytes was formed.

The result with lime, as these gentlemen had stated, was precisely analogous. Strontites and magnesia were decomposed in the same manner.

From strontites the expected result soon took place; but from magnesia, in the first trials, no amalgam could be procured. By continuing the process, however, for a longer time, and keeping the earth continually moist, at last a combination of the basis with mercury was obtained, which slowly produced magnesia by absorbing oxygen from the air, or by the action of water.

Mr Davy found that all these amalgams might be preserved for a considerable period under naphtha. In length of time, however, they became covered with a white crust under this fluid. In water, the amalgam of barytes was most rapidly decomposed; that of strontites and that of lime next in order: but the amalgam from magnesia, as might be expected from the weak affinity of the earth for water, very slowly changed. When a little sulphuric acid was added to the water, however, the evolution of hydrogen, and the production and solution of magnesia, were exceedingly rapid, and the mercury soon remained free.

Mr Davy believed, that one reason why magnesia was less easy to metallize, than the other alkaline earths, was

Zinc. was owing to its insolubility in water, which would prevent it from being presented in the nascent state, detached from its solution at the negative surface.

He then made the experiment, using moistened sulphate of magnesia instead of the pure earth; and the amalgam was much sooner obtained. Here the magnesia was attracted from the sulphuric acid, and probably deoxigenated and combined with the quicksilver at the same instant.

The amalgams of the other bases of the alkaline earths could be obtained in the same manner from their saline compounds: muriate and sulphate of lime, the muriate of strontites and barytes, and nitrate of barytes, were decomposed by the same means as the other earths. The earths, separated at the deoxigenating surface; these seemed instantly to undergo decomposition, and, seized upon by the mercury, were in some measure defended from the action of air, and from the contact of water, and preserved by their strong attraction for this metal.

In attempting to procure the metals of the alkaline earths, the latter were slightly moistened, and mixed with one-third of red oxide of mercury; the mixture was placed on a plate of platina; a cavity was made in the upper part of it to receive a globule of mercury, of from 50 to 60 grains in weight; the whole was covered by a film of naphtha, and the plate was made positive, and the mercury negative, by a proper communication with the battery of five hundred.

The amalgams obtained in this way were distilled in tubes of plate-glass, or in some cases in tubes of common glass. These tubes were bent in the middle, and the extremities were enlarged and rendered globular by blowing, so as to serve the purposes of a retort and receiver. The tube, after the amalgam had been introduced, was filled with naphtha, which was afterwards expelled, by boiling, through a small orifice in the end corresponding to the receiver, which was hermetically sealed when the tube contained nothing but the vapour of naphtha, and the amalgam. It was found immediately that the mercury rose pure by distillation from the amalgam, and it was very easy to separate a part of it; but to produce a complete decomposition was very difficult, as nearly a red heat was required for the purpose, and as at a red heat the bases of the earths instantly acted upon the glass, and became oxigenated. When the tube was large in proportion to the quantity of amalgam used, the vapour of the naphtha furnished oxygen sufficient to destroy part of the bases: and when a small tube was employed, it was difficult to heat the part used as a retort sufficient to drive off the whole of the mercury from the bases, without raising too highly the temperature of the part serving for the receiver, so as to burst the tube.

In consequence of these difficulties, in a multitude of trials, only a very few successful results were obtained; and in no case could our author be absolutely certain, that there was not a minute portion of mercury still in combination with the metals of the earths.

In the best result obtained from the distillation of the amalgam of barytes, the residuum appeared as a white metal, of the colour of silver. It was fixed at all common temperatures, but became fluid at a heat below redness, and did not rise in vapour when heated to redness, in a tube of plate-glass, but acted violently upon the glass, producing a black mass, which seemed to contain barytes, and a fixed alkaline basis, in the first degree of oxigenation. When exposed to air, it rapidly tarnished, and fell into a white powder, which was barytes. When this process was conducted in a small portion of air, the oxygen was absorbed and the nitrogen remained unaltered; when a portion of it was introduced into water, it acted upon it with great violence and sunk to the bottom, producing in it barytes; and hydrogen was generated. From the minuteness of the quantities obtained, neither its physical nor chemical qualities could be examined correctly. It sunk rapidly in water, and even in sulphuric acid, though surrounded by globules of hydrogen, equal to two or three times its volume; from which it seems probable, that it cannot be less than four or five times as heavy as water. It flattened by pressure, but required a considerable force to produce this effect.

The metals from strontites sunk in sulphuric acid, and exhibited the same characters as that from barytes, except in producing strontites by oxidation.

The metal from lime, Mr Davy has never been able to examine, either when exposed to air, or when under naphtha. In the case in which he was able to distil the quicksilver from it to the greatest extent, the tube unfortunately broke, while warm, and at the moment that the air entered, the metal, which had the colour and lustre of silver, instantly took fire, and burned with an intense white light into quicklime.

The metal from magnesia seemed to act upon the glass, even before the whole of the quicksilver was distilled from it. In an experiment in which the process was stopped before the mercury was entirely driven off, it appeared as a solid; having the same whiteness and lustre as the metals of the other earths. It sunk rapidly in water, though surrounded by globules of gas producing magnesia, and quickly changed in air, becoming covered with a white crust, and falling into a fine powder, which proved to be magnesia.

In several cases in which amalgams of the metals were obtained, containing only a small quantity of mercury, they were exposed to air on a delicate balance, and it was always found, that, during the conversion of metal into earth, there was a considerable increase of weight.

Mr Davy endeavoured to ascertain the proportions of oxygen and basis in barytes and strontites, by heating amalgams of them in tubes filled with oxygen, but without success. He satisfied himself, however, that when the metals of the earths were burned in a small quantity of air, they absorbed oxygen, gained weight in the process, and were in the highly caustic or unslaked state; for they produced strong heat by the contact of water, and did not effervesce during their solution in acids.

The evidence for the composition of the alkaline earths is then of the same kind as that for the composition of the common metallic oxides; and the principles of their decomposition are precisely similar, the inflammable matters in all cases separating at the negative surface in the galvanic circuit, and the oxygen at the positive surface.

Mr Davy has denominated the metals obtained from the alkaline earths, *barium*, *strontium*, *calcium*, and *magnium*.

In attempting the decomposition of the other earths, Mr

Zinc.

Mr Davy was less fortunate in obtaining distinct results; and he observes that the methods which have usually proved successful, as well as some others, failed. When alumina was subjected to the action of electricity, it was in a state of fusion with potash. In this process metallic globules were produced, but they consisted chiefly of the base of the alkali. Some appearances, however, shewed, that the alumina itself was decomposed; for when soda was employed, the metallic product obtained was less fusible than sodium itself, and when it was acted on by water, it produced soda and a white powder. When potash was fused with the alumina, and subjected to galvanic action, the metallic product decomposed water with great rapidity, and the solution obtained deposited alumina by the action of an acid. When potassium in the state of amalgam, with one-third of mercury, in contact with alumina, was negatively electrified under naphtha, and after the process had been continued for some time, the amalgam was added to water, a decomposition took place, and a solution was obtained, which produced a cloudiness on the addition of an acid; but all these results are to be considered as very imperfect evidence of the decomposition of alumina.

Mr Davy was still less successful in attempting the decomposition of silica, partly from its insolubility, and partly from its being scarcely, if at all, affected with electricity, when diffused in water, and placed in the galvanic circuit; but by following the same processes as in his experiments on alumina, some indications of decomposition appeared. When silica was fused with six parts of potash, and was placed in fusion in the galvanic circuit, metallic matter was obtained, from which, by exposure to the air, or by dropping it into water, a minute quantity of silica was reproduced. When potassium, amalgamated with one-third of mercury, and in contact with silica, was negatively electrified, he obtained a similar result; but in none of the experiments could the product obtained be considered as the pure base of the earth.

The earths of zirconia and glucina were also subjected to the action of galvanism, by processes similar to those which have now been described, and in both there were some indications of decomposition; but the results were not so perfect as to lead to any certain conclusion respecting their nature.

Decomposition of Sulphur and Phosphorus.

Sulphur.—Sulphur, which had formerly been considered as a simple substance, appears, from the experiments of some of the French chemists, and particularly those of Berthollet junior, to be a compound of sulphur and hydrogen. The latter chemist, in his experiments to investigate the nature of this substance, caused sulphur to pass through a coated glass tube, which was heated to whiteness; some indications of sulphurated hydrogen were obtained. He then formed metallic sulphurets, as of iron, copper, and mercury, and in these processes, which were performed in an earthen retort with great care, sulphurated hydrogen gas was also obtained. Water in the state of vapour being passed over sulphur in fusion, caused the evolution of sulphurated hydrogen; the water was not decomposed, for no trace of acid could be observed. It seemed only to have effected the disengagement of hydrogen from the sulphur.

Mr Davy, in the course of his experiments in galvanism, subjected sulphur to the action of that power. The sulphur which he employed was sublimed in a retort, filled with azotic gas, and it was kept hot till the commencement of the experiment. The reason of this preliminary process was, to avoid any uncertainty which might arise from water absorbed by the sulphur. The sulphur introduced into a curved tube, fig. 7. which was furnished with wires of platina A and B, the upper wire A being hermetically sealed into the end of the tube, was then placed in the galvanic circuit of a battery of 500 pairs of plates of six inches, in a state of great activity. A very intense action followed, accompanied by great heat and a brilliant light. The sulphur soon entered into ebullition, and gave out a great quantity of elastic fluid, a good deal of which was permanent. The sulphur itself assumed a deep red brown colour. The gas obtained was sulphurated hydrogen. In another experiment made on 200 grains of sulphur, the amount of sulphurated hydrogen obtained was equal to more than five times the volume of the sulphur. A considerable action was observed to have taken place on the wires of platina; and the sulphur, at its point of contact with the wires, reddened moist litmus paper. When sulphur and potassium are heated together, a very powerful action takes place. Sulphurated hydrogen is disengaged with very intense heat and light. From these experiments the conclusion seems fair and obvious, that hydrogen exists in sulphur, for a substance, as Mr Davy observes, which can be produced from it in such abundance, is not to be considered merely as an accidental ingredient.

But as it is admitted that sulphurated hydrogen contains oxygen, Mr Davy contends that oxygen is to be regarded as one of the constituents of sulphur. In this opinion he is supported by experiment. He heated potassium in sulphurated hydrogen gas, from which moisture had been as much as possible abstracted, by muriate of lime. The potassium took fire, and burnt with a brilliant flame. When four grains of potassium were heated in 20 cubic inches of gas, the quantity of gas diminished only about $2\frac{1}{2}$ cubic inches; but the properties of the gas were totally changed. A small portion only of it was absorbed by water, and the remainder was hydrogen, holding in solution a minute portion of sulphur. Some sulphur was observed on the sides of the retort, and a solid matter was formed, which on the surface was of a red colour, like sulphuret of potash, but internally dark gray, like sulphuret of potassium. By subjecting this substance to the action of muriatic acid, sulphurated hydrogen gas was obtained, but the proportion was less than would have been given out, had the potassium been in combination with pure combustible matter. From this Mr Davy concludes, that there is a principle in sulphurated hydrogen which is capable of destroying partially the inflammability of potassium, and of producing upon it all the effects of oxygen. As sulphurated hydrogen is obtained by heating sulphur strongly in hydrogen gas, Mr Davy introduced four grains of sulphur in a glass retort, containing about 20 cubical inches of hydrogen, and by means of a spirit lamp, he raised the heat nearly to redness. No perceptible change took place in the volume of the gas after the process. The sublimed sulphur was unchanged in its properties, and about three cubical inches of an elastic fluid, absorbable by water, reddening litmus, and having all the properties of sulphurated hydrogen gas, were formed. Supposing then sulphurated

Zinc.

sulphurated hydrogen to be constituted by sulphur dissolved in its unchanged state in hydrogen, and admit the existence of oxygen in this gas, its existence must likewise be allowed in sulphur. From these experiments Mr Davy thinks it not unreasonable to assume, that sulphur in its common state is a compound of small quantities of oxygen and hydrogen, with a large quantity of a base, which produces the acids of sulphur in combustion; and as this basis, it is added, possesses strong attractions for other bodies, it will probably be very difficult to obtain it in its uncombined state.

Sulphur combines readily with potassium, when brought into contact in tubes filled with the vapour of naphtha; heat and light are rapidly evolved during the combination, and a gray substance like artificial sulphuret of iron, is produced. The sulphurated hydrogen in small quantity is formed at the moment of combination, the hydrogen, of which, it is supposed, is derived from the sulphur. The sulphuret of potassium readily inflames, and when exposed to the air, it is gradually oxidated, and converted into sulphate of potash.

Sulphur also enters into combination with sodium, accompanied also with the evolution of heat and light. An explosion sometimes take place, which is owing to the volatilization of a portion of sulphur, and the disengagement of sulphurated hydrogen gas. The sulphuret of sodium is of a deep gray colour.

Phosphorus.—Mr Davy subjected phosphorus to similar experiments, and he found that the same analogies are applicable to this combustible. Common electrical sparks transmitted through phosphorus produces no evolution of permanent gas; but when acted upon by the same galvanic battery, and in the same circumstances as the sulphur, a considerable evolution of gas was effected, and the phosphorus became of a deep red brown colour. The gas was phosphorated hydrogen; and in an experiment continued for some hours, the quantity evolved was four times the volume of the phosphorus. The light by the galvanic spark was at first a brilliant yellow, and afterwards orange.

Three grains of potassium were heated in 16 cubical inches of phosphorated hydrogen. As the fusion was effected, the retort was filled with white fumes, and a reddish substance was deposited upon the upper part and sides; the heat was applied for some minutes, but no inflammation took place. When the retort cooled, the absorption was less than a cubical inch, the potassium externally was of a deep brown, and internally of a lead colour. The residual gas seemed to contain in solution a little phosphorus, but it had not the property of spontaneous inflammation. While the phosphuret was acted upon over mercury by a solution of muriatic acid, it gave out only $1\frac{1}{4}$ cubical inch of phosphorated hydrogen.

One grain of potassium, and one of phosphorus, were fused together. In combining, a very vivid light and intense ignition were produced; $\frac{1}{10}$ of a cubical inch of phosphorated hydrogen was evolved, and the phosphuret, with diluted muriatic acid over mercury, gave out $\frac{1}{10}$ of a cubical inch of phosphorated hydrogen. In another experiment with one grain of potassium, and three of phosphorus, nearly one-fourth of a cubical inch of phosphorated hydrogen was obtained; but the compound yielded by muriatic acid, only $\frac{1}{10}$ of a cubical inch.

From these experiments it is concluded, that phosphorated hydrogen contains a minute proportion of oxygen, and consequently that the same element enters into the composition of phosphorus. The deficiency of phosphorated hydrogen in the last experiment can only be referred to the supply of oxygen to the potassium from the phosphorus; and the quantity of phosphorated hydrogen produced in the experiment with equal parts of potassium and phosphorus, is much less than could be expected, if the potassium and phosphorus consisted merely of pure combustible matter.

Mr Davy also instituted a set of interesting experiments on the states of the carbonaceous principle in plumbago, charcoal, and the diamond, and the results of these are detailed in the same memoir; but for an account of them we must refer to the paper itself.

Decomposition of Boracic, Fluoric, and Muriatic acids.

The properties of boracic, fluoric, and muriatic acids, many of which are quite analogous to those of other acids whose elements have been discovered, have led chemists to conclude that oxygen is also the acidifying principle in the former; but the separate existence or nature of the base of these three acids was, till the late researches of galvanism were instituted, utterly unknown. The investigation of the nature of these substances has been prosecuted by Mr Davy, and some of the French chemists; and of their experiments we shall now give a very short account.

Boracic acid.—When boracic acid was moistened with water, and exposed between two surfaces of platina, and then subjected to the battery of 500 plates, an olive brown matter formed on the negative surface, and, increasing in thickness, appeared at last almost black. This substance was permanent in water, but it dissolved and effervesced in warm nitrous acid. Heated to redness on the platina, it burned slowly, and gave off white fumes, which reddened moistened litmus paper. A black mass remained, which through a magnifier appeared vitreous, and seemed to contain a fixed acid. The inference drawn from this experiment is, that the acid was decomposed, and again by the latter process reproduced.

When equal weights of potassium and boracic acid were heated together in a green glass tube, which had been exhausted, after being twice filled with hydrogen gas, an intense ignition, with vivid inflammation, where the potassium was in contact with the boracic acid, took place, even before the temperature approached near to a red heat. When the acid had been heated to whiteness, before being introduced into the tube, and powdered and used while yet warm, the quantity of gas which was hydrogen, given out in the operation, did not exceed twice the volume of the acid. In this mode of conducting the experiment, 12 or 14 grains of each of the two substances only could be employed, on account of the intense heat and consequent fusion of the glass tube with larger proportions. Mr Davy found in several experiments, in which he employed equal parts of acid and potassium, that a great proportion of the former remained undecomposed, and he ascertained that twenty grains of potassium had their inflammability destroyed by eight grains of boracic acid.

To collect the substances formed in the process, metallic tubes with stop-cocks, and exhausted, after being filled with hydrogen, were employed. With tubes of brass or copper, a dull red heat only, but with iron tubes, Zinc. tubes, a white heat was applied; and in all cases the acid was decomposed by the same results. The substance obtained from the iron tube was in some parts of a dark olive colour, and in others almost black. It did not effervesce with warm water, but was rapidly acted upon by it. The solutions obtained consisted of subborate of potash, and potash.

The following are the properties of the substance obtained in the decomposition of boracic acid by means of processes conducted in brass tubes, which afforded it in largest proportion. To this substance Mr Davy has given the name of *boracium*, which, as it is produced in the manner now described, is in the form of a pulverulent mass of the darkest shades of olive; it is opaque, very friable; the powder does not scratch glass, and is a non-conductor of electricity. Dried at 100° or 120°, it gives off moisture, by decreasing the temperature; and when heated in the atmosphere, takes fire at a temperature below the boiling point of olive oil, emitting a red light, and sparks like charcoal. When excluded from air, and subjected to a white heat in a platina tube, exhausted after being filled with hydrogen, it remains unchanged, excepting in becoming a little darker, and acquiring a greater specific gravity.

Boracium introduced into a retort filled with oxygen gas, and heated by a spirit lamp, throws off vivid scintillations like those of the combustion of the bark of charcoal, and the mass gives out a brilliant light. A sublimate appears, which is boracic acid; it becomes coated with a vitreous substance, which is also found to be the same acid. When this is washed off, the black residuum requires a greater heat, but it is also inflamed, and converted into boracic acid. When boracium is brought into contact with oxymuriatic acid gas, at common temperatures, it immediately takes fire, and burns with a brilliant white light, coating the inside of the vesssel with a white substance, which is boracic acid. Boracium heated to redness with hydrogen or nitrogen, became of a darker colour, and gave out a little moisture, but remained otherwise unchanged. Thrown into concentrated nitric acid, it rendered it bright red; nitrous gas was produced and absorbed, but no rapid solution took place till the acid was heated, when the boracium disappeared with effervescence and the evolution of nitrous gas, and the fluid yielded boracic acid. The action of boracium on sulphuric and muriatic acids was not remarkable. It combined with the fixed alkalies, both by fusion and aqueous solution, and formed pale olive-coloured compounds, which by muriatic acid were precipitated of a dark colour. When fused with sulphur, it dissolved slowly, and the sulphur became of an olive colour. Its action with phosphorus in the same circumstances was still feebler, but it communicated a shade of pale green.

From the experiments now detailed, it appears that boracium obtained by means of potassium, is different from any other known species of matter, and seems to be the same as that obtained from boracic acid by electricity. According to the result of experiments made by Mr Davy, boracic acid is composed of one part of boracium, and about 1.8 of oxygen; and supposing the dark residual substance to be an oxide, it consists of 4.7 of boracium, and 1.55 of oxygen.

For an account of the experiments of Gay Lussac and Thenard, in investigating the nature of boracic acid, see Jour. de Physique, tom. lxvii. or Nichol. Jour. xxiii. 260.

Fluoric acid.—According to the experiments of Mr Davy, potassium, when heated in fluoric acid gas, undergoes combustion, and a great absorption of the gas takes place. In other experiments, he found that when fluoric acid gas, procured in contact with glass, is introduced into a plate glass retort, exhausted after being filled with hydrogen gas, white fumes appear from the action of the potassium, which loses its splendour, and becomes coloured with a gray crust. The fumes are more copious when the bottom of the retort is gently heated. The volume of the gas examined at this time appears to be a little increased, with the addition of hydrogen; and when the temperature is raised nearly to the point of sublimation of the potassium, the metal rises through the crust, becomes first of a copper colour, and then inflames and burns with a brilliant red light. After this combustion, the fluoric acid is either wholly or partially destroyed, according as the quantity of potassium is great or small; and a mass of a chocolate colour is found in the bottom of the retort; the sides and the top are lined with a sublimate, which is partly chocolate, and partly of a yellow colour. When the residual gas is washed with water, mixed with oxygen gas, and exposed to the action of an electrical spark, it detonates, and affords a diminution in the same way as hydrogen gas.

In one experiment with 19 cubical inches of fluoric acid gas, and ten grains and a half of potassium, 14 cubical inches of the gas disappeared, and about two and a quarter of hydrogen gas were produced. The gas had not been artificially dried; little sublimate was produced, but the whole of the bottom of the retort was covered with a brown crust. When this mass was examined with a magnifier, it seemed to consist of different kinds of matter. It did not conduct electricity; it effervesced violently in water, with the evolution of an inflammable gas, which had somewhat of the odour of phosphorated hydrogen. Part of the mass heated in the air, burnt slowly, and was converted into a white saline matter. It also burnt with difficulty in heated oxygen gas, but it absorbed a portion that required nearly a red heat. The light emitted resembled that from the combustion of liver of sulphur. Chocolate-coloured particles were found floating in the water, acted on by a portion of the mass, and when the solid matter was separated by the filter, the fluid was found to contain fluate of potash and potash. The solid residuum was heated in a small glass retort filled with oxygen gas; it burnt before reaching a red heat, and became white. Oxygen was absorbed, and acid matter produced. The remainder had the properties of the substance formed from fluoric acid gas, holding siliceous earth in solution by the action of water.

"The decomposition of the fluoric acid, Mr Davy observes, by potassium, seems analogous to that of the acids of sulphur and phosphorus. In neither of these cases are the pure bases, or even the bases in their common form, evolved; but new compounds result, and in one case, sulphurets and sulphites, and in the other phosphurets and phosphites of potash, are generated."

In another experiment Mr Davy attempted the decomposition of fluoric acid gas, which was perfectly dry, and free from siliceous earth, by mixing 100 grs. of of dry boracic acid, and 200 grains of fluor spar. The mixture was introduced into the bottom of an iron tube, having a stop-cock and tube of safety attached. The tube was inserted horizontally in a forge, and 20 grains of potassium in an iron tray were placed in that part of it where the heat was only of a dull red. The bottom of the tube was raised to a white heat, and the acid, as it was generated, was acted upon by the heated potassium. The result obtained was a substance in some parts black, and in others of a dark brown colour. It did not effervesce with water, and when lixiviated, afforded a dark brown combustible mass which did not conduct electricity, and, when burnt in oxygen gas, afforded boracic and fluoric acids. This substance did not inflame spontaneously in oxymuriatic acid gas; but it effervesced violently, and dissolved in nitric acid. Mr Davy thinks that this substance is a compound of the olive-coloured oxide of boracium, and an oxide of the base of fluoric acid; but he had not examined its properties particularly.

Muriatic acid.—Many conjectures have been offered with regard to the nature and constitution of muriatic acid, and many attempts have been made to effect its decomposition. Mr Davy has extended his researches to this substance, and has prosecuted the investigation with his usual ardour. It is still, however, to be regretted, that his success has not been commensurate with his ingenuity and industry. Some have supposed, that the base of muriatic acid is hydrogen, while others contend that the base is a compound of hydrogen and nitrogen.

The result of Mr Davy's first experiments in this inquiry showed, that the water alone in combination with the muriatic acid is decomposed, and that this elastic fluid contains a larger proportion of water than is usually suspected; and from various experiments he concludes, that muriatic acid gas, in its common state, is combined with at least one-third of its weight of water. In the prosecution of his researches, therefore, his object was to obtain the muriatic acid free from water. With this view he heated dry muriate of lime, mixed both with phosphoric acid, and dry boracic acid, in tubes of porcelain and of iron, and employed the blast of an excellent forge; but by none of these methods was any gas obtained, till a little moisture was added to the mixture, and then muriatic acid was given out in such quantity as almost to produce explosions. In distilling the liquor of Libavius, or the fuming muriate of tin, which contains dry muriatic acid, with sulphur and with phosphorus, no separation of the acid took place; but with the addition of water, muriatic acid gas was evolved with great heat and violence. By distilling mixtures of corrosive sublimate and sulphur, and of calomel and sulphur in their common states, muriatic acid gas was evolved; but when these substances were dried by a gentle heat, the quantity of gas obtained was greatly diminished. Mr Davy, and also the French chemists, endeavoured to procure dry muriatic acid by the distillation of a mixture of calomel and phosphorus. The result obtained is considered as a compound of muriatic acid, phosphorus, and oxygen. In Mr Davy's experiments, the product was more copious when corrosive sublimate was employed. With the same view of procuring dry muriatic acid gas, he exposed phosphorus to the action of oxymuriatic acid gas, in the hope that in the oxidation of the phosphorus, the whole of the moisture would be absorbed; but the examination of the result showed, that no muriatic acid gas had been evolved during the process, so that the muriatic acid which had disappeared, must exist, either in the white sublimate which had collected in the top of the retort, or in a limpid fluid which had formed in its neck. When the sublimate was exposed to the air, it emitted fumes of muriatic acid, and when brought into contact with water, muriatic acid gas was evolved, and phosphoric and muriatic acids remained in solution in the water. Mr Davy regards this white sublimate as a combination of phosphoric and muriatic acids in their dry states. The limpid fluid was of a pale greenish yellow colour; it rapidly disappeared on exposure to the air, emitting dense white fumes, which had a strong smell, differing a little from that of muriatic acid. Mr Davy thinks that this is a compound of phosphoric and muriatic acids, both free from water.

Mr Davy made other experiments, for the purpose of procuring muriatic acid in its uncombined state, but with no better success. He then tried the effects of potassium introduced into the fluid generated by the action of phosphorus on corrosive sublimate; but such was the violent action of the substances operated upon, that the apparatus was generally destroyed, and he was thus precluded from examining the results. But for a particular detail of the experiments, we must refer to the memoir itself; and for the extended account of Mr Davy's investigations on this curious and interesting subject, of which we have given as comprehensive a view as our limits would permit, see CHEMISTRY, SUPPLEMENT.

ZINNIA, a genus of plants of the class *syngenesia*, and in the natural system arranged under the 49th order, *Compositæ*. See BOTANY *Index*.

ZINZENDORFF, NICHOLAS LEWIS, COUNT, was the noted founder of the German religious sect called *Moravians* or *Herrnhuters*, or, as they pretend, the restorer of that society. From his own narrative, it appears, that when he came of age in 1721, his thoughts were wholly bent on gathering together a little society of believers, among whom he might live, and who should entirely employ themselves in exercises of devotion under him. He accordingly purchased an estate at Bertholsdorff in Upper Lusatia, where, being joined by some followers, he gave the curacy of the village to a person of his own complexion; and Bertholsdorff soon became talked of for a new mode of piety. One Christian David, a carpenter, brought a few proselytes from Moravia: they began a new town about half a league from the village, where Count Zinzendorff fixed his residence among them, and whither great numbers of Moravians flocked and established themselves under his protection: so that in 1732 their number amounted to 600. An adjacent hill, called the *Huthberg*, gave occasion to these colonists to call their new settlement *Huth des Herrn*, and afterwards *Herrnhuth;* which may be interpreted "The guard or protection of the Lord:" and from this the whole sect have taken their name. The count spared neither pains nor art to propagate his opinions; he went himself all over Europe, and at least twice to America; and sent missionaries throughout the world. Count Zinzendorff died in 1760. Those who wish to know more of the Moravian tenets may consult Rimius's account

account of them, translated in 1753. See UNITED BRETHREN.

ZISCA, JOHN, a famous general of the forces of the Hussites, in the 15th century, was a gentleman educated at the court of Bohemia, in the reign of Wenceslaus. He entered very young into the army, and after distinguishing himself on several occasions, lost an eye in a battle, whence he was called *Zisca* or *One-eyed*. At length the Reformation, begun by John Huss, spreading through almost all Bohemia, Zisca placed himself at the head of the Hussites, and had soon under his command a body of 40,000 men. With this army he gained several victories over those of the Romish religion, who carried on a kind of crusade against them, and built a town in an advantageous situation, to which he gave the name of *Tabor;* whence the Hussites were afterwards called *Taborites*. Zisca lost his other eye by an arrow at the siege of the city of Rubi; but this did not prevent his continuing the war, his fighting battles, and gaining several great victories, among which was that of Ausig on the Elbe, in which 9000 of the enemy were left dead on the field. The emperor Sigismund, alarmed at his progress, caused very advantageous proposals to be offered to him; which he readily accepted, and set out to meet Sigismund, but died on the road. He ordered that his body should be left a prey to the birds and wild beasts; and that a drum should be made of his skin, being persuaded that the enemy would fly as soon as they heard the sound. It is added, that the Hussites executed his will; and that the news of this order made such an impression on the disturbed imaginations of the German Papists, that in many battles they actually fled at the beat of the drum with the utmost precipitation, leaving their baggage and artillery behind them.

ZINZIBER, or ZINGIBER. See AMOMUM, BOTANY and MATERIA MEDICA *Index*.

ZION, or SION, in *Ancient Geography*, a very famous mountain, standing on the north side of the city of Jerusalem, (Psal. xlviii. 2.); containing the upper city, built by King David; and where stood the royal palace, (Josephus. Psal. xlviii. 2.). A part of Zion, situated at its extremity, was called *Millo*, of or in the city of David, (2 Chron. xxxii. 5.). Modern travellers, who have been upon the spot, say, that Zion is the whole of the mountain, on which Jerusalem stands at this day, though not to the extent in which it anciently stood on the same mountain, as appears Psal. ix. 12. 15. lxv. 1. lxxxvii. 2. 3. Is. lxii. 1. It is swelled into several eminences or tops; as Moriah, Acra Bezetha, and Zion a particular eminence or mount, and Zion Proper, &c. encompassed on three sides, east, west, and south, with one continued very deep and steep valley; by means of which it was impregnable on these three sides, and always attacked and taken, according to Josephus, by the enemy on the north side, where Mount Zion became level, and the vales of Gihon and Jehoshaphat gradually lose themselves. This deep and steep valley incontestably constitutes the compass of the old Jerusalem on those three sides, as plainly appears to any person who has been upon the spot. Contrary to the opinion of former travellers, Dr Clarke thinks that the proper Mount Zion is an eminence entirely without the city on the south side; and in the valley between this and the city he places the holy sepulchre. That part of the valley which lay to the east was called *Jehoshaphat's*, having Mount Olivet lying beyond it; that to the south *Gehinnon;* and that to the west *Gihon*, from cognominal mountains lying beyond them. At the west end of Gihon, without the city, stood Golgotha or Calvary. Dr Clarke thinks that very little credit is due to the names given to the different places and objects by the monks. There is another *Zion*, the same with HERMON.

ZION, or *Zion College*. See LONDON, N° 76.

ZIPH, or SIPH, in *Ancient Geography*, the name of a wilderness or desert in the tribe of Judah, where David was fugitive; lying to the south-east of Hebron; so called from Ziph or Siph, a twofold town in this tribe; the one more to the south towards Idumea, on the confines of Eleutheropolis, (Jerome); the other eight miles to the east of Hebron, towards the Dead sea, inclining southwards, because near Mount Carmel. Here was a mountain, mentioned 1 Sam. xxiii. 14. in which David abode, said by Jerome to be rugged, dismal, and always overcast. *Ziphim, Ziphæi* or *Ziphenses*, the inhabitants of Ziph, ver. 19.

ZIRCHNITZER-SEE, otherwise called the *Lake of Czircknitz*, in Carniola, is about one German or four English miles in length, and half as much in breadth, contains three beautiful islands, and is encompassed at some distance with mountains and forests. But what is most remarkable is, that it disappears generally once a-year, about St John's or St James's day, running off through holes or pits in the bottom; sometimes it disappears twice or thrice a-year, and sometimes even in winter if the weather be dry. On the other hand, it has been known to continue two or three years without running off. Of the holes or pits, there are five much larger than the rest, each of which successively, when the water runs off, stands empty five days; so that the whole lake becomes dry in 25. As soon as the beginning of the ebb is observed, the fishing in the pits begins, which belongs to five seignories. The fish, which are carp, tench, pike, eels, and two other sorts called *schleien* and *ruten*, are caught by laying nets over the holes. Mr Keysler tells us, that upon the ringing of a bell at Zirknitz, when the waters begin to fall, the peasants, both men and women, run to the pools quite naked.

ZIRCON, a mineral substance containing a peculiar earth. See MINERALOGY *Index*.

ZIRCONIA, a peculiar earth. See CHEMISTRY *Index*.

ZIZANIA, a genus of plants of the class monœcia; and in the natural system arranged under the 4th order, *Gramina*. See BOTANY *Index*.

ZODIAC, a broad circle, whose middle is the ecliptic, and its extremes two circles parallel thereto, at such a distance from it as to bound or comprehend the excursions of the sun and planets, (see ASTRONOMY). It is a curious enough fact, that the solar division of the Indian zodiac is the same in substance with that of the Greeks, and yet that it has not been borrowed either from the Greeks or the Arabians. The identity, or at least striking similarity, of the division, is universally known; and M. Montucla has endeavoured to prove, that the Bramins received it from the Arabs. His opinion, we believe, has been very generally admitted; but in the second volume of the Asiatic Researches, the accomplished president Sir William Jones has proved unanswerably, that neither of those nations borrowed that division from the other; that it has been known among the

Zodiac ‖ Zoophytes.

the Hindoos from time immemorial; and that it was probably invented by the first progenitors of that race, whom he considers as the most ancient of mankind, before their dispersion. The question is not of importance sufficiently general, straitened as we are by the limits prescribed us, for our entering into the dispute; but we think it our duty to mention it, that our astronomical readers, if they think it worth their while, may have recourse to the original writers for further information.

ZOEGEA, a genus of plants of the class syngenesia. See BOTANY *Index*.

ZONE, in *Geography* and *Astronomy*, a division of the terraqueous globe with respect to the different degrees of heat found in the different parts thereof. The zones are denominated torrid, frigid, and temperate. The torrid zone is a band, surrounding the terraqueous globe, and terminated by the two tropics. Its breath is 46° 58′. The equator, running through the middle of it, divides it into two equal parts, each containing 23° 29′. The ancients imagined the torrid zone uninhabitable. The temperate zones are contained between the tropics and the polar circles. The breadth of each is 43° 2′. The frigid zones are segments of the surface of the earth, terminated, one by the antarctic, and the other by the arctic circle. The breadth of each is 46° 58′.

ZOOLOGY, is that part of natural history which relates to *animals*. See NATURAL HISTORY.

ZOOPHYTES. The name ZOOPHYTES, *Zoophyta* (i. e. *animal plants*, from ζωον, *animal* and φυτον, *plant*,) has been long appropriated to a numerous assemblage of marine or aqueous productions, which have puzzled the ingenuity of naturalists to ascertain their place in the chain of nature's works, and which have been alternately ranked among vegetable and animal, and sometimes even among mineral substances. At length, however, they seem, by general consent, to have been consigned over to the animal kingdom, and, with the addition of several tribes from the Linnæan orders of *Intestina*, *Mollusca* and *Infusoria*, have, by Cuvier and his colleagues of the French school, been elevated to the rank of a separate class. See HELMINTHOLOGY, N° 11.

In the Linnæan system, the zoophytes of earlier modern naturalists constitute the 4th order of the class VERMES, and as such have been enumerated under HELMINTHOLOGY; but as the circumscribed limits of that article did not admit of our describing or figuring many species, we shall now as far as possible supply that deficiency by selecting a few of the most curious or interesting species of the Linnæan zoophytes; and we shall take this opportunity of making a few observations on some of the genera to which they belong.

Tubipora Musica. Plate DLXXIX. Fig. 1. & 2.

Fig. 1. and 2. represent the TUBIPORA *musica*, *crimson tubipore*, or *organ coral*; one of the most elegant of these singular productions. This species is distinguished from its congeners by *having the tubes connected into fasciculæ* or *bundles, and separated from each other by transverse membranous partitions.* The whole mass consists of upright parallel tubes, rising over each other by stages, something like the cells of a honeycomb. These tubes vary in height from half an inch to an inch; and are from one-tenth to one-eighth of an inch in diameter. Examined internally, they appear to contain a smaller tube divided at certain distances by radiated partitions (see fig. 2.), by means of which the transverse *septa* sometimes communicate with each other. These transverse *septa* are of unequal heights. The colour of the mass is a deep purple, or a rich crimson. The size of the mass varies considerably; but specimens have been obtained of from a foot to three feet in diameter. It is found abundantly in the Pacific ocean, and on the shores of some of the islands in the Indian sea.

In its recent state it is covered with a mucous or gelatinous substance, which pervades the whole mass and enters within each tube. The inhabiting animal is not certainly ascertained, but seems to be allied to the *nereis* tribe.

Madrepora fungites. Fig. 3. & 4.

Figs. 3. and 4. exhibit two views of the MADREPORA *fungites*, or *mushroom madrepore*. This body so exactly resembles a mushroom that it has very commonly been regarded as that vegetable in a state of petrifaction; but recent observations seem to prove that it is formed by small animals like *medusæ*. The convex side of this madrepore is conical, sometimes obtusely pointed, and exhibits on its surface those stellated pores which form the distinguishing character of the genus, while the concave surface is divided into numerous radiated furrows so as to represent the *gills* of a mushroom. When first obtained, it is of a delicate white colour, especially on the concave part, but it soon acquires a brown or yellowish tinge. It is found of various sizes, from an inch to six inches in diameter. It is met with chiefly in the Indian ocean and Red Sea.

Isis hippuris. Fig. 5. & 6.

At fig. 5. is represented that elegant coral called by Linnæus ISIS *hippuris*, the *black and white jointed coral* of Ellis. The specific character of this coral is that it is *composed of white striated joints united by black junctures;* but that structure is not visible till after the coral has been freed from a whitish soft spongy part, with which the branches are covered in their natural state. See fig. 6. It is found chiefly in the Indian seas, and varies in height from a few inches to nearly two feet.

Antipathes myriophylla Plate DLXXX. Fig. 7. & 8.

Fig. 7. represents the ANTIPATHES *myriophylla, yarrow antipathes*, or *sea-yarrow*, of its natural size; while fig. 8. shews one of the pinnæ considerably magnified.

This is one of those zoophytes which in their habit and appearance almost exactly resemble some of the vegetable tribes, and hence have received the names of *sea-heath*, *sea-cypress*, *sea-fennel*, &c. From their colour they are usually denominated *black coral.* This species, though one of the smallest, is not the least elegant of the tribe. It consists of numerous branches, composed of very slender pinnæ arranged in no certain order. The whole coral is seldom above a foot in height, and rough on its outer surface. This also is a native of the Indian ocean, being found more especially on the coasts of the Molucca islands, and is sometimes met with in the Great South sea.

Gorgonia nobilis. Fig. 9. & 10.

Fig. 9. exhibits a specimen of *red coral*, the ISIS *nobilis* of Linné, and GORGONIA *nobilis* of later naturalists. This substance, though now nearly exploded from the *materia medica*, will still retain a place in our cabinets for its intrinsic beauty and elegant appearance; but when examined on its native beds, or soon after being fished up, it shews a very different surface from that under which we usually see it. Fig. 9. represents it as prepared for sale by being deprived of its fleshy animal *bark* or coating, but retaining the striated appearance which marks its specific character; but fig. 10. exhibits a piece of it in its natural state, with polypes extruded from the fleshy coat, and shewing still more distinctly at the extremities the streaks below.

Zoophytes.

Red coral is found in large beds or reefs in several parts of the Mediterranean sea, and coral fisheries are established on the coasts and near the islands. A fishery of this kind in the straits of Messina is minutely described by Spallanzani in his *Travels in the two Sicilies*, vol. iv. To tear the coral from the rocks, they make use of a machine composed of two beams tied across each other, and furnished with a leaden weight to sink them, and a quantity of loose hemp and several strong nets to entangle the branches of the coral. To this machine is attached a strong rope, which is held by the fishers, and serves both to direct the net and to draw it up when the coral is entangled. Several boats go in company, each containing eight men, and the fishery lasts from April to July. The quantity collected every year amounts on an average to twelve Sicilian quintals, each equal to 250 pounds Troy, and each pound usually sells for about four shillings and sixpence. They do not fish on the same bank oftener than once in ten years, as this time is deemed necessary for the coral to acquire its full size and vigour.

Gorgonia ceratophyta. Fig. 11.

Another beautiful species of gorgonia, the GORGONIA *ceratophyta*, is figured at fig. 11. This is distinguished by its *dichotomous flattish stem, and ascending branches.* The outer flesh is of a purplish colour, and the branches are furnished with two rows of scattered pores from which the polypi appear. It is found in the Mediterranean, and sometimes on the eastern coasts of America.

Alcyonium gorgonoides. Fig. 12.

Nearly allied to the gorgoniæ is the species of alcyonium represented at fig. 12. This is the ALCYONIUM *gorgonoides* of Gmelin. It is of a cinereous colour, of a sandy fleshy consistence, having radiated warty cellules. It is found on the northern coast of South America, especially near the island of Curaçoa.

The zoophytes which naturalists distinguish by the generic name alcyonium, sometimes form independent bodies of a rounded form, such as those called the *sea-orange, sea-fig*, &c.; or cover the surface of shells and other marine bodies like a kind of bark. Their internal part or base is friable, and, when dried, appears to be composed of fine fibres, which are either longitudinal, as in the present case, diverging, or circular. This base is covered with a soft crust, that in drying assumes a leathery consistence, and is pierced with numerous little cells inhabited by polypi. In some species these cells are dispersed over the whole surface of the coral, while in others they are confined to particular spots or tubercles. They are all inhabitants of the ocean, where they are usually fixed to rocks or other solid bodies.

Spongia tubulosa. Plate DLXXXI. Fig. 13.

In the article HELMINTHOLOGY we have sufficiently treated of the nature and properties of the sponges, and have there mentioned particularly the common or *officinal* sponge. At fig. 13. is represented a more curious species, the SP. *tubulosa* or *fistularis*, the *tubular* or *pipey sponge*. This consists of simple upright, attenuated, rigid tubes, tuberculated on the outer surface, which is of a black colour. It is found in the seas that wash the coasts of America.

Flustra arenosa. Fig. 14.

The *flustræ* are a tribe of insignificant zoophytes, which seem scarcely entitled to the rank which they hold in the animal creation. They are formed of a congeries of superficial cells, placed close together, like those of a honeycomb, but generally occupying only a single surface. Sometimes this substance forms a coating to some other marine body, at others it is unattached and forms a floating foliaceous mass or *mat*. The species represented at fig. 14. is one of the most curious, and is described by Ellis under the name of *English sea-mat*, called in the *Linnæan Transactions*, vol. v. FLUSTRA *arenosa*. It is composed of sandy particles agglutinated together with slime, and in shape resembles the fore part of a horse's hoof. It is very friable, and so thin as to be easily broken. These *flustræ* are found abundantly on the coast of Kent, and about Holy-head on the Welsh coast.

Sertularia setacea. Fig. 15. & 16.

Fig. 15. represents a specimen of SERTULARIA *setacea*, the *small sea-bristle coralline* of Ellis, of its natural size; and fig. 16. shews the same specimen considerably magnified. This species is distinguished by being *simply pinnated, with bent alternate pinnæ, furnished with very remote processes growing only on one side, and oblong axillary ovaries.* It is one of the smallest and most delicate of the tribe, seldom exceeding an inch and a half in height. It is very common, and is found on the British coasts.

None of the zoophytes bear a nearer resemblance to vegetables than the *sertulariæ*. Their creeping roots, their branched stem, and tufts of seeming flowers (the polypine processes) give them all the air of plants. Hence they were long considered as *sea-mosses*, and described by botanists under that name. See Ray's *Synopsis*, p. 38. and 39. When attentively examined, however, their animal nature will scarcely be disputed. Externally they are composed of a horny substance, perfectly transparent, and through this may be distinguished the animal substance traversing the centre of the stem and branches like the pith of a plant, and appearing externally as little knots or protuberances in the form of tentaculated polypes. These extraneous polypes are considered by Cuvier (*Tableau Elementaire*, p. 768.) not as distinct animals, but only as parts of the same animal which constitutes the sole inhabitant of the sertularia. These zoophytes adhere to rocks, shells, &c. by creeping roots, and appear to propagate by means of eggs. They are among the most common of this class of animated beings.

Pennatula phosphorea. Fig. 17. & 18.

The PENNATULÆ, or *Sea-pens*, constitute a very curious tribe of zoophytes, which are completely locomotive, and swim in the manner of fishes. They consist of an internal bone or rather horny substance, covered with a sensible fleshy coat. Their lower extremity is simple like the barrel of a quill, while the upper extremity is expanded into a flattened part, that is generally composed of pinnæ like the barbs of a quill, though it is sometimes merely a simple expanded mass furnished with polypine processes.

Fig. 17. represents one of the most common *sea-pens* properly so called, the PENNATULA *phosphorea, phosphorescent pennatula*, of its natural size. It has *a fleshy stem, a rough middle part, and imbricated pinnules.* The pinnæ are furnished on one side with lesser *pinnulæ*, at the extremities of which appear the polypes. See fig. 18. which shews one of the separate pinnæ, a little magnified. This species is of a fine red or light scarlet colour, and when alive exhibits a strong phosphorescent light, so as to render distinctly visible objects that are near it. It is pretty common on the coasts of Britain, and is sometimes taken in the fishermen's nets, or adhering to the baits.

For figures of two other Linnæan zoophytes, see Plate CCLIII. TUBULARIA *magnifica*, and HYDRA *viridis*,

ZOOPHYTES. PLATE DLXXIX.

Fig. 1.

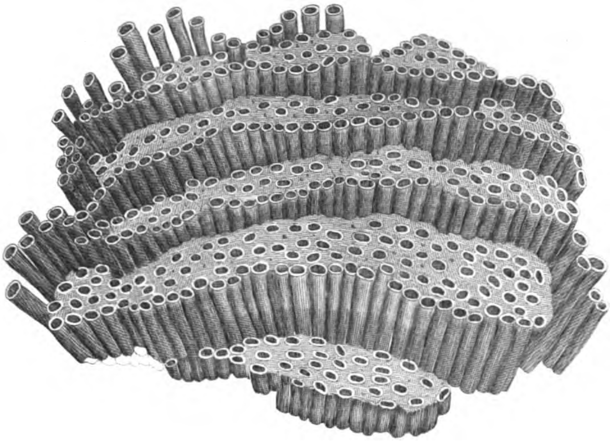


Fig. 2.

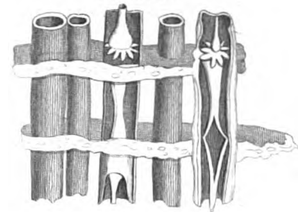


Fig. 3.

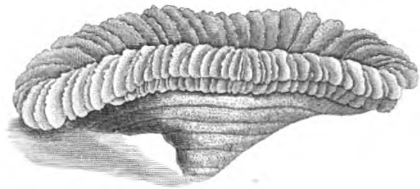


Fig. 4.

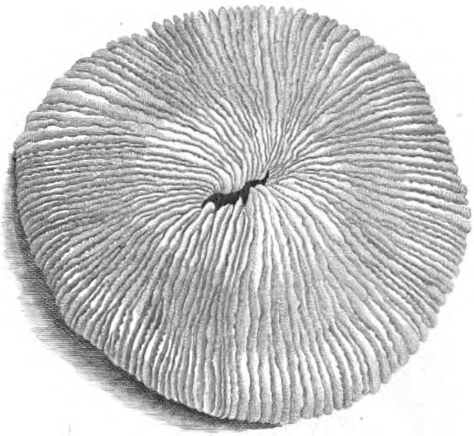


Fig. 5.

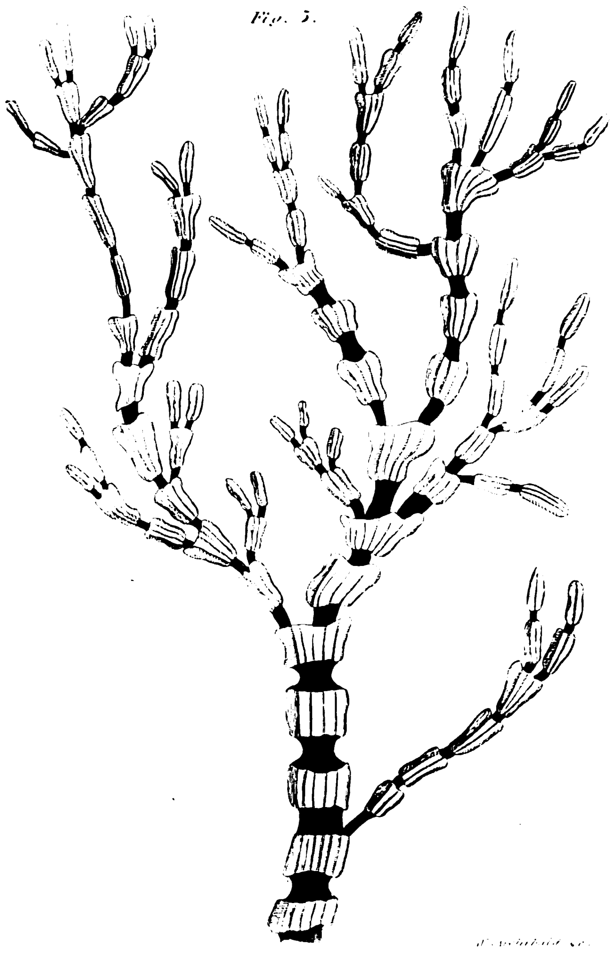
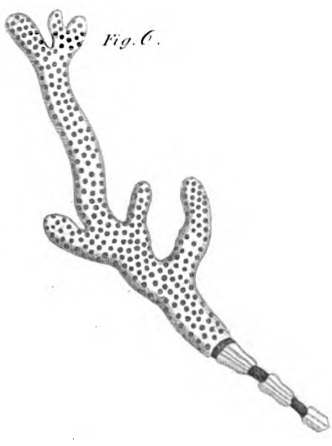


Fig. 6.



ZOOPHYTES. PLATE DLXXX.

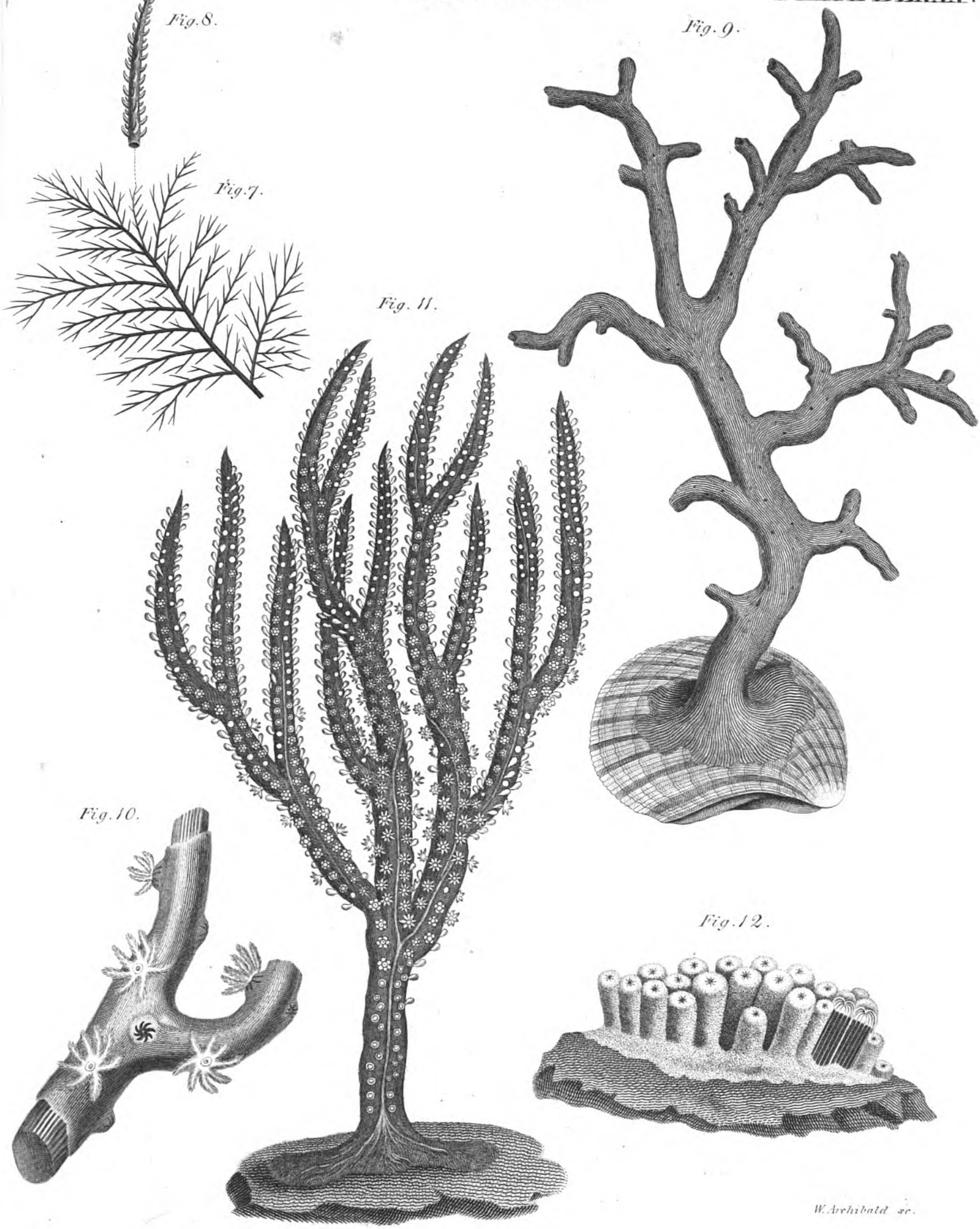


Fig. 13.

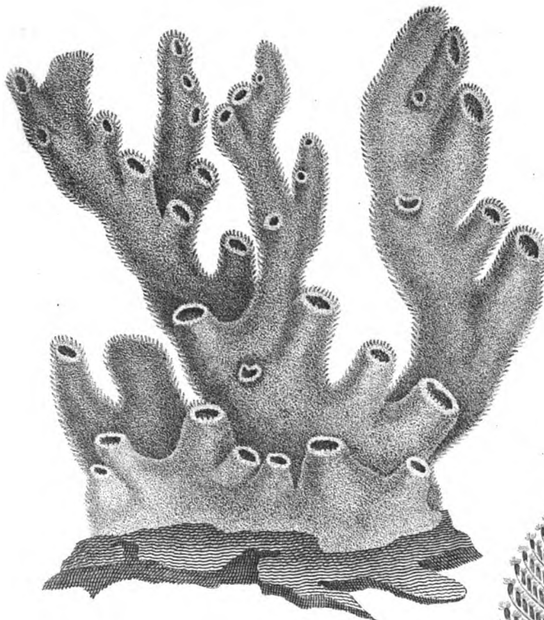


Fig. 14.

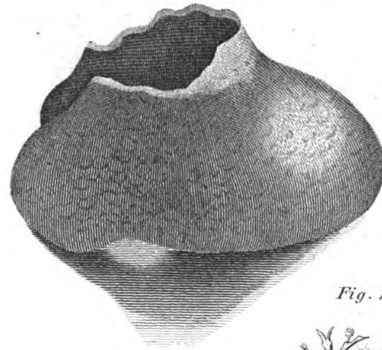


Fig. 16.

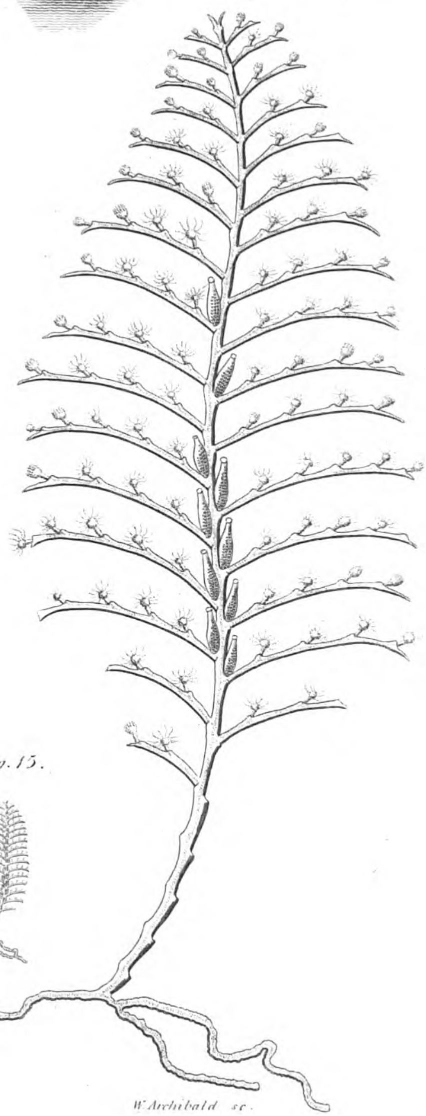


Fig. 17.

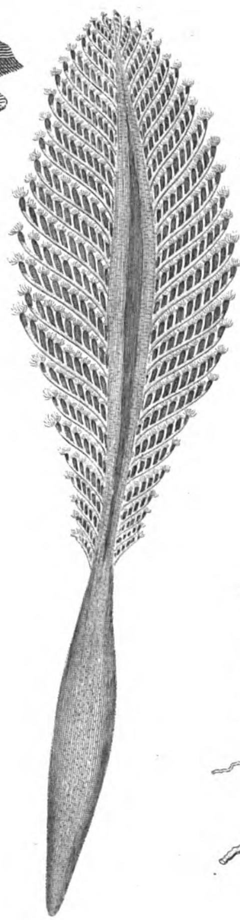


Fig. 18.

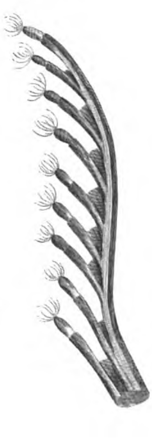


Fig. 15.

W. Archibald sc.

CCLIII. Several of Cuvier's zoophytes are represented in Plates XXXIV. CCLI. and CCLII. and some of the *Infusoria* in Plates XXXV. and XXXVI.

ZOOTOMY, the art of dissecting animals or living creatures, being the same with anatomy. See ANATOMY.

ZORILLE, a species of weasel which inhabits Peru, and other parts of South America; and is said to be remarkable for its fetid odour.

ZOROASTER, or ZERDUSHT, a celebrated ancient philosopher, said to have been the reformer or the founder of the religion of the magi. It is wholly uncertain to how many eminent men the name of Zoroaster belonged. Some have maintained that there was but one Zoroaster, and that he was a Persian; others have said that there were six eminent founders of philosophy of this name. Ham the son of Noah, Moses, Osiris, Mithras, and others, both gods and men, have by different writers been asserted to have been the same with Zoroaster. Many different opinions have also been advanced concerning the time in which he flourished. Aristotle and Pliny fix his date at so remote a period as 6000 years before the death of Plato. According to Laertius, he flourished 600 years before the Trojan war; according to Suidas, 500. If, in the midst of so much uncertainty, any thing can be advanced with the appearance of probability, it seems to be this; that there was a Zoroaster, a Perso-Median, who flourished about the time of Darius Hystaspes; and that besides him there was another Zoroaster, who lived in a much more remote period among the Babylonians, and taught them astronomy. The Greek and Arabian writers are agreed concerning the existence of the Persian Zoroaster; and the ancients unanimously ascribe to a philosopher, whom they call *Zoroaster*, the origin of the Chaldean astronomy, which is certainly of much earlier date than the time of Hystaspes: it seems, therefore, necessary to suppose a Chaldean Zoroaster distinct from the Persian. Concerning this Zoroaster, however, nothing more is known, than that he flourished towards the beginning of the Babylonish empire, and was the father of the Chaldean astrology and magic. All the writings that have been ascribed to Zoroaster are unquestionably spurious.

ZOSTERA, a genus of plants of the class gynandria, and in the natural system arranged under the second order, *Piperitæ*. See BOTANY *Index*.

ZOSIMUS, an ancient historian who lived at the end of the fourth and beginning of the fifth century. There are six books of his history extant; in the first of which he runs over the Roman affairs in a very succinct manner from Augustus to Dioclesian; the other five are written more diffusely. Zosimus was a zealous Pagan; whence we find him frequently inveighing with great bitterness against the Christian princes, particularly against Constantine the Great, and the elder Theodosius. His history has been published with the Latin version of Leunclavius at Frankfort, 1590, with the other minor historians of Rome, in folio; and at Oxford in 8vo, 1679.

ZUG, a canton of Switzerland, bounded on the east and north by that of Zurich, on the south by Schweitz and Lucern, and on the west by the canton of Lucern and the Freye-Amt or Free Provinces. It is not above 12 miles either way; but very populous and fruitful, yielding wine, wheat, chesnuts, and other fruits, in its vales, and excellent pasture on its mountains. The inhabitants of this canton are staunch Roman Catholics. It lies in the diocese of Constance, and its government is democratical. There are two lakes in it abounding in fish, particularly large carps, pikes, and a species of trouts called *rotels;* as well as several woods full of game. Zug, which gives name to it, and is its capital, stands on the east side of a lake of the same name, about seven miles long, and is a strong neat town, containing a priory and two convents.

ZUILA, a town in the territory of Fezzan, in Africa, which stands on a space of about a mile in circuit, but was formerly of much greater extent. The environs are level, well supplied with water, and fertile, planted with groves of date-trees, and the inhabitants pay much attention to agriculture. N. Lat. 27. 29. E. Long. 16. 39.

ZUINGLIUS, ULRICUS, an able and zealous reformer, who laid the foundation of a separation from Rome in Switzerland, at the same time that Luther did the like in Saxony, was born at Wildehausen in 1487. While he officiated as preacher at Zurich, a Franciscan sent by Leo X. came to publish indulgences there; against which Zuinglius, after the example of Luther, declaimed powerfully. In the course of this opposition he started a new doctrine, which he called *Evangelical Truth;* and from the beginning of 1519 to 1523, he preached not only against indulgences, but against other articles of the Romish church. But though Zuinglius made no less progress than Luther, he conducted himself with more moderation and prudence; and wishing to have the concurrence of the civil powers, procured two assemblies to be called at Zurich: by the first, he was authorised to proceed as he had begun; and by the second, the outward worship and ceremonies of the church of Rome were abolished. During these transactions, Zuinglius published several books in defence of his doctrines; but treating of the eucharist, and prescribing a form of celebrating the Lord's Supper different from Luther, he was involved in violent disputes with the rest of his reforming brethren. Respecting the divine DECREES, the opinion of Zuinglius and his followers differed very little from that of the PELAGIANS: and instead of declaring with Calvin, that the church is a separate independent body, vested with the right of legislation for itself, Zuinglius ascribed to the civil magistrate an absolute and unbounded power in religious matters, allowing at the same time a certain subordination among the ministers of the church. This was abundantly agreeable to the magistrates of Zurich; but the rest of the Swiss cantons disallowing of their proceedings, other assemblies were called, and things tending to tumult, both sides had recourse to arms; when Zuinglius, who began as a preacher, died in arms as a soldier, in 1531. His works are in four volumes folio.

ZURICH, a canton of Switzerland, bounded to the north by Swabia and the canton of Schaffhausen; to the south by the town and territory of Rapperschweil and the cantons of Switz and Zug; to the east by the Thurgau, Toggenburg, and Utznach; and to the west by the free bailiages and county of Baden. It is about 60 miles from north to south, and 48 from east to west. With respect to its face, air, and soil, it is said to be an epitome of all Switzerland, as containing in it hills, valleys,

valleys, plains, corn-lands, vineyards, lakes, and rivers. Their wines have a tartness at first, but the longer they are kept the more agreeable they are. The other products are excellent fruits, corn, pasture, fine clay, chalk, several coloured earths, pit-coal, turf, and sulphur. There are also some mineral springs in the canton, and some lakes; Zurich is the most considerable, it is 24 miles long, and two broad. The reformation was introduced here by Zuinglius in the year 1517. This canton is the first in rank, and inferior only to that of Bern in extent, power, and wealth; in consequence of which, its representatives preside in the general diets, when held in any place belonging in common to the cantons; and the affairs relating to the whole confederacy are transacted in its offices. Its quota, for the defence of the several members of the confederacy, is 1400 men. Of one of the two armies raised on these occasions, it nominates one of the commanders in chief, as Lucern does the other. Its revenue is said to be about 150,000 crowns a-year; of which, one year with another, two thirds are expended in the charges of government, and the rest laid up in the treasury. It can bring 50,000 fighting men into the field at a very short warning.

ZURICH, the capital of a canton of the same name in Switzerland, stands in a pleasant country, near where the river Aa issues from the lake that takes its name from the town, 23 miles from Schaffhausen, and 114 from Geneva. After having been ruined by Attila the Hun, it is said to have been restored by Thuricus, son of Theodoric king of the Goths, from whom it took the name of *Thuricum*, corrupted afterwards into that of *Zurich*. It is fortified in the modern way, and has wide ditches, faced with free-stone. There are five arsenals in it, well stored with arms and artillery; an academy or college, having 15 professors; a museum, or chamber of rarities; a stately town-house, the pillars in the front of which are of black marble, streaked with white; and a town library. The sovereignty and administration of all affairs are lodged in the greater and lesser council, out of which are chosen the city-officers, as the councils are out of the 13 companies of burghers. There are several other councils or colleges, each of which has its particular department. Here are a great variety of silk, woollen, linen, cotton, and other manufactures; this being the place of the greatest trade in all Switzerland. The town is well supplied with provisions by and from its lake. The streets are neat, and houses well built, but not magnificent. In the town-library are several letters to Bullinger from Lady Jane Gray, daughter to the duke of Suffolk. In one of the arsenals is the figure of William Tell, dressed and armed in the ancient Swiss manner, with the cross-bow whence he shot the arrow that struck the apple off his child's head.

Both men and women are so fond of music, that there are few of them that cannot play on some instrument. If a burgher goes out of town, or a peasant enters it, without a sword, they are liable to be fined. No persons, whatever their rank or office may be, are exempted from the sumptuary laws. The burgomasters, who are the same as the advoyers at Bern, have the title of excellence. The hospitals here are neat and well endowed. The environs are pleasant and fruitful; for which it is not a little indebted to the lake. That part of it which is next Zurich is called the *Lower Lake*, and the other end the *Upper*. The cathedral, or great church here, is collegiate. The present city is said to owe its origin to a nunnery, founded by the emperor Lewis I. near where the ancient Tigurum stood. E. Long. 8. 30. N. Lat. 47. 20.

ZUTPHEN, a strong and considerable town of the province of Guelderland, in the kingdom of the Netherlands, and capital of a county of the same name. It has a magnificent church, and is surrounded with walls. It was taken by the French in 1672, who in 1674 delivered it up to the States-General. It is seated at the confluence of the rivers Berkel and Yessel, nine miles south-east of Deventer, and 55 east by south of Amsterdam. E. Long. 6. 0. N. Lat. 52. 10.

ZUYDER-ZEE, a great gulf or bay of the German ocean, which extends from south to north in the United Provinces, between Friesland, Over-Yessel, Guelderland, and Holland. It is so called from its situation towards the south. It is said that the Zuyder-zee was formerly a lake, and that the land is swallowed up which united North-Holland with Friesland.

ZYGOMA, a bone of the head, or rather an union or assemblage of two processes or eminences of bones. See *Bones of the Head*, under ANATOMY.

ZYGOMATICUS, a muscle of the head, arising from the *Os* ZYGOMA, whence its name, and terminating at the angle of the lips.

ZYGOPHYLLUM, BEAN-CAPER, a genus of plants of the class of decandria, and in the natural system arranged under the 14th order, *Gruinales*. See BOTANY *Index*.

ZYMOSIMETER (formed from ζυμωσις, *fermentation*, and μετρον, *measure*), an instrument proposed by Swammerdam, in his book *De Respiratione*, with which to measure the degree of fermentation occasioned by the mixture of different matters, and the degree of heat which those matters acquire in fermenting; the same instrument is employed to ascertain the heat or temperament of the blood of animals.

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DIRECTIONS FOR PLACING THE PLATES OF VOL. XX.

PART I.

Plate DXIII.—DXXIV.	to face	page 112
DXXV.—DXXVII.	- -	120
DXXVIII.	- - -	232
DXXIX.—DXXXI.	- -	272
DXXXII.	- - -	280
DXXXIII. & DXXXIV.	-	400

PART II.

DXXXV.	- - -	410
DXXXVI.	- - -	432
DXXXVII. & DXXXVIII.	-	488
DXXXIX.	- - -	496
DXL.	- - -	512
DXLI.—DXLIII.	- -	542
DXLIV.—DLXX.	- -	632
DLXXI. & DLXXII.	- -	646
DLXXIII. & DLXXIV.	- -	680
DLXXV. & DLXXVI.	- -	686
DLXXVII.	- - -	700
DLXXVIII.	- - -	792
DLXXIX.—DLXXXI.	- -	804